



**METROLINK®**  
**SCRRRA**  
**STANDARD**  
**SPECIFICATIONS**

---



**FINAL**

---

**February 2022**

**SCRRA  
STANDARD SPECIFICATIONS  
TABLE OF CONTENTS**

SECTION NO.	TITLE	PAGES	ISSUED DATE
-------------	-------	-------	-------------

<b>DIVISION 01 – GENERAL REQUIREMENTS</b>			
01 11 13	Work Covered by the Contract Documents	3	02.2022
01 11 15	Definition of Terms and Referenced Standards	16	02.2022
01 11 16	Work by SCRRA	4	05.2022
01 14 00	Work Restrictions	11	02.2022
01 14 16	Coordination With SCRRA	5	02.2022
01 14 19	Coordination with Utilities	6	02.2022
01 21 00	Allowances	3	02.2022
01 22 00	Unit Prices	2	02.2022
01 22 05	Lump-Sum Prices	1	02.2022
01 23 00	Options	2	02.2022
01 23 50	Time-Related Overhead	4	05.2022
01 24 13	Value Engineering Change Proposals (VECP)	3	02.2022
01 25 00	Substitution Procedures	5	02.2022
01 26 14	Request for Information	3	02.2022
01 29 73	Schedule of Values	4	02.2022
01 31 00	Project Management and Coordination	7	02.2022
01 31 19	Partnering	1	02.2022
01 31 99	Period of Performance (2 Step NTP)	5	02.2022
01 32 17	Construction Project Schedule	15	02.2022
01 32 33	Photographic Documentation	4	02.2022
01 33 00	Submittal Procedures	17	02.2022
01 35 15	Maintenance and Protection of Railroad Traffic	2	02.2022
01 35 23	Site Safety Requirements	6	02.2022
01 35 44	Environmental Safety and Health Program	5	05.2022
01 35 91	Historic Treatment Procedures	15	02.2022
01 40 00	Quality Requirements	13	02.2022
01 43 23	Contractor Qualifications and Requirements	19	02.2022
01 55 26	Maintenance and Protection of Roadway Traffic	3	02.2022
01 56 37	Worksite Security Requirements	3	02.2022
01 56 38	Bird Protection	2	02.2022
01 56 39	Temporary Tree and Plant Protection	8	02.2022
01 57 19	Temporary Environmental Controls	5	02.2022
01 60 00	Product Requirements	4	02.2022
01 64 00	SCRRA Furnished Material and Equipment	2	02.2022
01 71 13	Mobilization, Demobilization, and Controls	12	02.2022
01 71 23	Field Engineering	4	02.2022
01 74 19	Construction Waste Management and Disposal	3	02.2022
01 77 00	Substantial Completion	5	02.2022
01 77 19	Project Closeout	3	02.2022
01 78 23	Operation and Maintenance Data	8	02.2022
01 78 36	Warranties and Guarantees	4	02.2022
01 78 39	Project Record Documents	4	02.2022
01 79 00	Demonstration and Training	9	02.2022

**SCRRRA  
STANDARD SPECIFICATIONS  
TABLE OF CONTENTS**

SECTION NO.	TITLE	PAGES	ISSUED DATE
01 91 13	General Commissioning Requirements	4	02.2022
<b>Division 03 – Concrete</b>			
03 21 00	Reinforcing Steel	13	02.2022
03 31 00	Structural Concrete	25	02.2022
<b>Division 04 – Masonry</b>			
04 22 00	Concrete Unit Masonry	8	02.2022
04 22 10	Environmental Paving	10	02.2022
<b>Division 05 - Metals</b>			
05 12 23	Structural Steel	9	02.2022
05 52 00	Hand Rails and Railing	7	02.2022
05 52 10	Pedestrian Swing Gates	4	02.2022
05 53 00	Metal Grating	6	02.2022
05 55 00	Miscellaneous Metals	6	02.2022
<b>Division 09 – Finishes</b>			
09 61 50	Detectable Warning Tactile	9	02.2022
09 90 00	Painting and Coating	5	02.2022
09 96 23	Graffiti-Resistant Coating	3	02.2022
<b>Division 10 – Specialties</b>			
10 14 53	Roadway Signage	10	02.2022
10 14 55	Railroad Signage	4	02.2022
<b>Division 12 – Furnishings</b>			
12 67 23	Benches and Trash Containers	3	02.2022
<b>Division 26 – Electrical</b>			
26 05 00	Basic Electrical Materials and Methods	10	02.2022
26 05 43	Electrical: Exterior Underground	12	02.2022
26 05 50	Overcurrent Protective Device Coordination	10	02.2022
26 06 00	Grounding and Bonding	10	02.2022
26 07 10	Seismic Controls for Electric Works	7	02.2022
26 07 50	Electrical Identification	4	02.2022
26 08 00	Electrical Testing	3	02.2022
26 12 00	Conductors and Cables - Low Voltage	15	02.2022
26 13 00	Conduits, Raceways, and Boxes	12	02.2022
26 14 00	Wiring Devices	5	02.2022
26 28 00	Overcurrent and Short Circuit Protective Devices	8	02.2022
26 28 16	Safety Switches	6	02.2022
26 28 90	Transient Voltage Suppression	10	02.2022
26 41 00	Enclosed Switches and Circuit Breakers	5	02.2022
26 42 00	Enclosed Controllers	8	02.2022
26 44 10	Switchboards	9	02.2022
26 44 20	Service Pedestals and Panelboards	7	02.2022
26 46 00	Dry Type Transformers (600V and Less)	4	02.2022
26 50 00	Interior and Exterior Lighting	12	02.2022
<b>Division 28 – Electronic Safety and Security</b>			
28 13 00	Access Control System (ACS)	23	02.2022

**SCRRRA  
STANDARD SPECIFICATIONS  
TABLE OF CONTENTS**

SECTION NO.	TITLE	PAGES	ISSUED DATE
28 23 00	Video Surveillance System (VSS)	34	02.2022
<b>Division 29 – Customer Information System (CIS)</b>			
29 00 00	Summary of Customer Information System (CIS) Work	5	02.2022
29 00 20	Standards, Abbreviations, and Definitions for CIS	4	02.2022
29 10 60	Power Distribution Testing and Commissioning	3	02.2022
29 20 20	Communications Services	19	02.2022
29 20 60	System Testing and Commissioning	2	02.2022
<b>Division 31 - Earthwork</b>			
31 11 00	Site Clearing	6	02.2022
31 11 50	Demolition, Cutting, and Patching	9	02.2022
31 20 00	Earthwork	27	02.2022
31 20 50	Removal and Disposal of Contaminated Soils	15	05.2022
31 50 00	Excavation Support	11	02.2022
<b>Division 32 – Exterior Improvements</b>			
32 12 00	Hot Mix Asphalt (HMA) Pavement	8	02.2022
32 16 00	Curbs, Gutters, and Sidewalks	3	02.2022
32 17 23	Pavement Markings	3	02.2022
32 31 13	Chain Link Fencing and Gates	8	02.2022
32 31 16	Welded Wire Fencing and Gates	4	02.2022
32 31 19	Tubular Steel Fencing and Gates	5	02.2022
32 31 32	Vehicular Gate Operator System	10	02.2022
32 32 16	Gravity Block Retaining Walls	5	02.2022
32 32 20	MSE Retaining Walls	21	02.2022
32 80 00	Irrigation System	10	02.2022
32 90 00	Landscaping	6	02.2022
32 91 00	Soil Erosion, Sediment Control, Top Soiling and Seeding	18	02.2022
<b>Division 33 – Utilities</b>			
33 05 23	Steel Casing	7	02.2022
33 42 00	Culvert and Drainage Pipe	17	02.2022
33 46 00	Underdrains	5	02.2022
<b>Division 34 – Transportation</b>			
<b>Track Materials</b>			
34 11 10	Continuous Welded Rail (CWR)	25	02.2022
34 11 15	Other Track Materials (OTM)	9	02.2022
34 11 23	Special Trackwork	9	02.2022
34 11 26	Ballast	6	02.2022
34 11 27	Sub-Ballast and Aggregate Base	3	02.2022
34 11 33	Concrete Railroad Ties	30	02.2022
34 11 34	Wood Railroad Ties	13	02.2022
34 11 36	Elastic Rail Fasteners	8	02.2022
34 11 40	Precast Concrete Grade Crossing Panels	7	02.2022
<b>Railroad Signals</b>			

**SCRRRA  
STANDARD SPECIFICATIONS  
TABLE OF CONTENTS**

SECTION NO.	TITLE	PAGES	ISSUED DATE
34 42 00	General Signal Requirements	18	02.2022
34 42 10	Coordination with SCRRRA Procurement Contractor	2	02.2022
34 42 16	Signal Wires and Cables	9	02.2022
34 42 18	Conduits and Pull Boxes	7	02.2022
34 42 25	Signal Fiber Network	25	02.2022
34 42 38	Interlocking Controls	6	02.2022
34 42 40	Solid-State Coded Track Circuits	5	02.2022
34 42 42	Signal Layout, Structures, and Foundations	7	02.2022
34 42 43	Electric Switch Lock Layouts	4	02.2022
34 42 44	Relays	5	02.2022
34 42 46	Signal Equipment Houses	15	02.2022
34 42 48	Power Switch and Lock Movement	5	02.2022
34 42 50	Switch Circuit Controller	5	02.2022
34 42 52	Rectifiers, Batteries, and Battery Charging Equipment	4	02.2022
34 42 54	Rail Bonding	3	02.2022
34 42 56	Signal Grounding	4	02.2022
34 42 58	Signal System Testing	13	02.2022
34 42 60	Signal Systems Miscellaneous Products	9	02.2022
34 42 62	Service Meters	4	02.2022
34 42 64	Highway-Rail Grade Crossing Warning Systems	13	02.2022
34 42 66	Dragging Equipment Detector Systems	3	02.2022
34 42 70	Wayside Signal Assemblies	7	02.2022
34 42 75	Positive Train Control Wayside Equipment	6	02.2022
<b>Railroad Communications</b>			
34 44 00	Railroad Communications Requirements	14	02.2022
34 44 05	Communications Basic Equipment, Materials, and Methods	10	02.2022
34 44 10	Prefabricated Communications Shelter	8	02.2022
34 44 20	Communications Wire and Cable	11	02.2022
34 44 50	Customer Information Systems	11	02.2022
34 44 70	Wide Area Network	14	02.2022
34 44 95	Data Radio Network	9	02.2022
<b>Highway-Rail Grade Crossings</b>			
34 71 50	Highway-Rail Grade Crossings	9	02.2022
<b>Track Construction</b>			
34 72 00	Trackwork	18	02.2022
34 72 20	Track Shifting, Relocation, and Resurfacing	8	02.2022
34 72 30	Field Welding Rail	7	02.2022
34 72 40	Track Collector Pan System	4	02.2022
<b>Railroad Bridges</b>			
34 80 11	Stone Revetment (Riprap)	9	02.2022
34 80 21	Piling	19	02.2022
34 80 22	Cast-In-Drilled Hole (CIDH) Piles	27	02.2022

**SCRRRA  
STANDARD SPECIFICATIONS  
TABLE OF CONTENTS**

SECTION NO.	TITLE	PAGES	ISSUED DATE
34 80 23	Subdrainage System for Railroad Bridges and Retaining Walls	8	02.2022
34 80 24	Augercast Pile Headwall and Wingwall	9	02.2022
34 80 31	Bridge Deck Drainage System	5	02.2022
34 80 32	Adhered Elastomeric Waterproofing for Railroad Bridges	8	02.2022
34 80 33	Hot Mix Asphalt (HMA) for Track and Bridges	6	02.2022
34 80 43	Precast and Prestressed Concrete for Railroad Bridges	11	02.2022
34 80 51	Structural Steel for Railroad Bridges	16	02.2022
34 80 52	Metal Fabrications for Railroad Bridges	13	02.2022
34 80 53	Steel Handrails for Railroad Bridges	8	02.2022
34 80 61	Painting and Protective Coating for Bridges	25	02.2022

## SECTION 01 11 13

### WORK COVERED BY THE CONTRACT DOCUMENTS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This section summarizes requirements and provisions for the Contractor's execution of the Work under this Contract.

##### 1.02 DESCRIPTION

Refer to the Project Specifications for a summary of the Work. The general intent of the Contract, Specifications, plans, and all other Contract Documents and provisions thereof is that the Contractor shall:

- A. Furnish all tools, qualified labor, materials, equipment, qualified superintendence and all services, other incidentals, assurances and guarantees, assumptions of risk, and responsibility for the performance of the Work as set forth in the Contract Documents unless otherwise specifically provided.
- B. Begin Work promptly and proceed expeditiously and continuously without cessation or shutdown of Work unless otherwise specifically approved in writing by the Authority, or directed by the Contract.
- C. Perform, complete, and make ready for its intended purpose, within the times specified, including additional times provided for certain conditions, the Work or parts thereof covered by the Contract, all in accordance with plans, specifications, and any addendum thereto and such direction or instructions as the Authority may give to supplement the plans and specifications. The Contractor shall retain sole responsibility and expense for Quality Control of their work products.
- D. The Work of the Project requires that the Authority and all its Contractors maintain an active working railroad signal and highway warning system in accordance with Federal regulations and CPUC orders at all times. The Contractor, shall integrate, coordinate, and stage the work in order to ensure that the active railroad signal and highway warning systems are maintained.
- E. Any construction staging plans or details are not meant to be contradictory to the requirements set forth in the contract documents. It is the responsibility of the Contractor to schedule and coordinate the construction activities at each site, using the Site- Specific Work Plan (SSWP) process. Tracks may be taken out of service for planned activities through the SSWP process. The Contractor shall incorporate into its SSWP the necessary Authority provided signal maintenance support. No red or other restrictive signals or signal-related train bulletins shall be allowed outside of the approved work windows and as approved in the SSWP (see also Section 01 14 00 "Work Restrictions").

### 1.03 INTENT OF PLANS AND SPECIFICATIONS

- A. The intent of the Plans and Specifications is to prescribe the details for the construction and completion of the Work that the Contractor undertakes to perform in accordance with the terms of the Contract. Where the Plans or Specifications describe portions of the Work in general terms, but not complete detail, it is understood that only commonly accepted industry practice is to prevail. Unless otherwise specified, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals, and perform all the Work involved in executing the Contract in a satisfactory and workmanlike manner.
- B. The Authority will determine whether the Work has been completed in accordance with the Contract, Plans, Specifications and reference Specifications. The Authority will decide all questions that may arise as to the quality or acceptability of materials furnished and Work performed, and regarding the interpretation of the Plans, Specifications, and reference Specifications.
- C. Plans, Standard Specifications, and Project Specific Specifications are essential parts of the Contract, and a requirement indicated in one is binding as though indicated in all. They are intended to be cooperative and to describe and provide for the complete Work. If there is a conflict between documents the most stringent applies.
- D. Words and abbreviations that have well-known technical or trade meanings are used in the Contract Documents in accordance with such recognized meanings.
- E. The word "Furnish" or the word "Install" or the word "Perform" or the word "Provide" or the word "Supply," or any combination or similar directive or usage thereof, shall mean furnishing and incorporating in the Work including all necessary labor, materials, equipment, and everything necessary to perform the Work indicated, unless specifically limited in the context used.
- F. The organization of the Specifications into divisions, sections, parts, and paragraphs, and the arrangement of the Plans, shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade. Study and compare the Contract Documents and immediately report to the Authority any error, inconsistency, or omission that may be discovered. The Contractor shall be liable to the Authority for any damage resulting from any such unreported errors, inconsistencies, or omissions in the Contract Documents.
- G. The Specifications may vary in form, format and style. Some specification sections are written in varying degrees of streamlined or declarative style and some sections may be relatively narrative by comparison. Omissions of such words and phrases as "the Contractor shall," "in conformity with," "as shown," or "as specified" are intentional in streamlined sections. Omitted words and phrases shall be supplied by inference. Similar types of provisions may appear in various parts of a section or articles within a part depending on the format of the section. The Contractor shall not take advantage of any variation of form, format or style in making claims for extra Work.



- H. The cross referencing of specification sections under the subparagraph heading "Related Requirements" and elsewhere within each specification section is provided as an aid and convenience to the Contractor. The Contractor shall not rely on the cross referencing provided and shall be responsible to coordinate the entire Work under the Contract Documents and provide a complete Project whether or not the cross referencing is provided in each section or whether or not the cross referencing is complete.
- I. The Work herein covered is to be completed in accordance with the Specifications, the accompanying plans, and such instructions or directions as the Authority may give to supplement Plans and Specifications. Wherever the words "directed," "permitted," "approved," "acceptable," "satisfactory to," or similar words or phrases occur in the Contract Documents, they shall be understood to be functions of the Authority.
- J. The Authority shall not be responsible for and shall not have control or charge over the acts or omissions of the Contractor, Subcontractors, or any of their agents or employees, or any other persons performing any of the Work.
- K. The word "Vendor" used in the Material Specifications shall mean the Contractor.

#### **1.04 REFERENCE MATERIAL**

Reference Specifications or Standards referred to in the plans, Standard Specifications, or Project Specific Specifications shall be the most recent version in effect as of the bid due date of this Contract. Where referenced standards refer to the "Specifications," this shall mean Standard Specifications, the Contract Drawings, and the Project Specific Specifications of this Contract. Where referenced standards refer to the "special provisions or conditions," this shall mean the Contract Drawings or the Specifications of this Contract. The Contractor is responsible for obtaining all reference material at its own expense, and for making itself familiar with the requirements therein.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 11 13**

**SECTION 01 11 15****DEFINITION OF TERMS AND REFERENCE STANDARDS****PART 1 - GENERAL****1.01 SUMMARY**

This Section provides definition of terms, abbreviations and reference standards cited in the Contract Documents. The following definitions supplement definitions provided throughout the Contract Documents including General Conditions Section 2.

**1.02 DEFINITION OF TERMS**

- A. Wherever in the Specifications and other Contract Documents, the following terms and abbreviations or pronouns in place of them, are used, the intent and meaning shall be interpreted as provided in this section unless the context otherwise requires.
1. **Active Track:** Any track within the Operating System on which trains and/or on-track equipment operate or may potentially operate. All tracks shall be considered by the Contractor to be Active unless otherwise instructed by the Authority.
  2. **Adjacent Track:** a controlled or non-controlled track whose track center is spaced less than 25 feet from the track center of the occupied track.
  3. **Adjusted Rail Laying Temperature:** The actual average rail temperature achieved at the time of rail installation.
  4. **Amtrak:** The current Authority Contractor for the train and engineer service. The National Railroad Passenger Corporation (Amtrak) also is the nationwide intercity passenger service. Amtrak's Surfliner trains operate over the River, Ventura, and Orange Subdivisions.
  5. **Authority:** The Authority is the Southern California Regional Rail Authority (SCRRA), a five-county joint powers authority, created pursuant to California Public Utilities Code Section 130255 and California Government Code Sections 6500 et seq., to build and operate the "METROLINK" commuter train system. The five-county member agencies are: Los Angeles County Metropolitan Transportation Authority (LACMTA), Orange County Transportation Authority (OCTA), Riverside County Transportation Commission (RCTC), San Bernardino County Transportation Authority (SBCTA), and Ventura County Transportation Commission (VCTC).
  6. **Automatic Block Signals:** A signaling system where the track is broken up into segments called "blocks," and the presence of a train on a given block will activate signals preventing other trains from entering that block, except as prescribed by the General Operating Rules.
  7. **Auxiliary Track:** Any track not otherwise specified that directly connects to any main track, siding or industrial lead where cars or locomotives are left standing

8. **Bad Order:** A defective rail car or any other rail equipment, track or structure, which is in need of mechanical attention or repair.
9. **Ballast:** Material selected for placement on the roadbed for the purpose of holding the track in line and at surface.
10. **Centralized Traffic Control:** A signaling system where a Train Dispatcher monitors the movements of all trains over a large territory on a display panel, and remotely controls the throwing of switches and the clearing of signals. CTC is a block system that uses block signal indications to authorize train movements.
11. **Clearance Diagram:** An outline or cross section drawing representing the minimum clearance that must be maintained from the Authority's track to allow for the operation of trains and rail mounted equipment. Specific limiting dimensions have been established and are shown on standard clearance diagrams known as "plates."
12. **Clearance Point:** the location closest to a switch where it is safe for equipment, and a person riding the side of equipment unless prohibited, to pass equipment on an adjacent track. Away from turnouts, the clearance point is designated as 13 feet center to center of two tracks.
13. **Coach:** A passenger carrying rail car, usually with a center aisle and two rows of twin seats.
14. **Common Carrier:** One who holds himself out to the general public to transport property and passengers, intrastate, interstate or in foreign commerce for compensation. Common carriers must operate from one point to another over routes or in territory prescribed by the Surface Transportation Board (interstate) and by a Public Service or Public Utilities Commission.
15. **Conductor (Train Operations):** The individual in charge of the train crew.
16. **Contaminated Soils:** All material excavated from the project site that meets the definition of contamination, regardless of material, gradation or other material property classifications.
17. **Continuous Welded Rail (CWR):** Rail length that is 400 feet or longer. Rail installed as CWR, remains CWR, regardless of whether a joint or plug is installed into the rail at a later time.
18. **Contract Documents:** The complete set of documents, describing the specific Work to be performed by the Contractor as part of the Contract.
19. **Coupler:** A device located at both ends of all cars and locomotives in a standard location and configuration to provide a means for connecting one rail vehicle to another.
20. **Creosote:** A tar distillate produced by high-temperature carbonization of bituminous coal and used in wood treatment.

21. Crossing Protection: Signs, signals, aspects, and other objects governing movement of trains, track equipment, and highway vehicles over railroad crossings or grade crossings.
22. Cross Level: The difference in elevation between the tops of both rails measured along a line perpendicular to the track centerline.
23. Crossover: Two turnouts in which the track between the frogs is arranged to form a continuous passage between two adjacent and generally parallel tracks.
24. Cross Tie: The transverse member of the track structure to which the rails are spiked or otherwise fastened to provide proper gage and to cushion, distribute, and transmit the stresses of traffic through the ballast to the roadbed.
25. Current of Traffic: The movement of trains on a main track, in one direction, specified by the General Operating Rules.
26. Departure Track: One of the tracks in a rail yard on which outgoing cars are placed.
27. Derail: A safety device attached to one rail of a siding or storage track, that will cause derailment of a car, engine or on track machinery, in order to prevent unintended and undesired movement to other tracks.
28. Derailment: Anytime the wheels of a rail car engine or on track machinery come off the head of the rail.
29. Dispatcher: Person stationed in the Operations Control Center who monitors and directs movement of trains.
30. Dynamic Stabilizer: The dynamic stabilizer is a machine that sets the track in horizontal oscillation while applying a static vertical load at the same time. Dynamic track stabilization is to achieve improved anchoring of the track in the ballast bed. After dynamic stabilization, the condition of the track offers greater operating safety and enables travel at the maximum subdivision speed on newly laid track or after full track maintenance.
31. Emergency: Any sudden generally unforeseen occurrence such as a fire, flood, storm, earthquake, epidemic, civil disorder or other natural and/or man-made disaster that has the potential to adversely affect the safety of life, the Work, and/or adjacent property; to interrupt contracts essential to the provision of railroad passenger and/or freight service; and/or to cause catastrophic failure of revenue-producing equipment and/or facilities.
32. Employee-in-Charge (EIC): When used in these specifications, Roadway Worker in Charge (RWIC) will replace all locations where Employee-In-Charge (EIC) is stated. See RWIC
33. Engineer: The designer of the contract documents.
34. Engineman: The driver or operator of a locomotive. Also called a locomotive engineer.

35. Embankment (fill): the material placed on a prepared surface
36. Excavation (Cut): the material removed to expose the ground surface upon which the roadbed, embankment fills, or other proposed improvements, will be placed.
37. Federal Agencies: Whenever, in the Contract Documents, reference is made to any Federal agency or officer, such reference shall be deemed made to any agency or officer succeeding, in accordance with law, to the powers, duties, jurisdiction and authority of the agency or officer mentioned.
38. Field Side: The side of rail opposite the gage side or on the outside of the running surface of any rail.
39. Field Weld: A weld joining two rails together after rails are installed in track.
40. Foul: A condition of placement of personnel, material, or equipment in such a proximity to a railroad track that the individual or equipment could be struck by a moving train or on track equipment or in case is within eight (8) feet of the field side of the nearest running rail.
41. Guard Rail: A rail or other structure laid parallel with the running rails of a track to prevent wheels from being derailed; or to hold wheels in correct alignment to prevent their flanges from striking the points of turnout or diamond crossing or the points of switches. A rail or other structure laid parallel with the running rails of a track to keep derailed wheels adjacent to running rails.
42. Insulated Switch: A switch in which the fixtures, principally the gage plates and the switch rods, connecting or reaching from one rail to the opposite rail, are provided with insulation so that the electric track circuit will not be shunted.
43. Interlocking: An arrangement of signals and signal appliances so interconnected that their movements must succeed each other in proper sequence and for which interlocking rules are in effect. It may be operated manually or automatically.
44. Job Briefing: A meeting among all of the employees who are involved or will be involved in a particular task or a job at the same work site. The briefing must be conducted before conducting any task and/or any employee fouls the track.
45. Ladder Track: A track connecting successively the body tracks of a yard.
46. Lead Track: An extended track connecting to a series of yard tracks
47. Live Track: See Active Track.
48. Locomotive: A self-propelled unit of equipment, or combination of units operated under a single control, and designed solely for moving other equipment.
49. Maintenance of Way Operating Rules (MOWOR): When used in these specifications, MOWOR will replace SCRRRA General Code of Operating Rules.

50. Maintenance-of-Way Safety Rules (MOWSR): When used in these specifications, SCRRA Maintenance-of-Way Safety Rules (MOWSR) will replace all locations where SCRRA Maintenance-of-Way Safety Instructions is stated. If a particular section of the old MOWSI was called out, Contractor shall review the new MOWSR for the updated section reference.
51. Main Track: A term referring to the primary or most heavily used tracks of a railroad. A track extending through yards and between stations, upon which the operation of trains is controlled and authorized by the Train Dispatcher. Note that sidings on Authority property are operated under the same rules as the Main Track(s).
52. Milepost: Designated location(s) along the main and branch lines normally sequentially one mile apart and indicated by nearby numbered sign corresponding to the "mile" location.
53. Operating Envelope: An imaginary line, measured 20 feet horizontally from the rail on the track on which trains or "on-track" equipment operate or may potentially operate. The Operating Envelope also includes the width and length of any active station platform. This imaginary pair of lines, which define the outside boundaries of the Operating Envelope, extend vertically up and down infinitely.
54. Operating System: Includes but is not limited to the tracks on which trains and on-track equipment operate or may potentially operate, and in addition any facilities closely related to the operation of the railroad system including signal and communication masts, bridges, poles, cables, and houses, track bridges, tunnels, culverts, grade crossings and station platforms."
55. Overexcavation: Removal of material beyond the outermost limits of the proposed improvements or embankment fills to replace poor quality native material in order to establish competent subgrade. See "Subgrade Preparation".
56. Passing Track: A track connected to the main track for meeting or passing trains. Today this is called a siding.
57. Preferred Rail Laying Temperature: The temperature that the rail is to be installed at, or adjusted to, in order to balance the thermal expansion and contraction forces for optimum track maintenance practices. The Preferred Rail Laying Temperature (PRLT) is defined in the SCRRA Track Maintenance Manual.
58. Qualified: A designation by the Authority of personnel who have demonstrated an understanding of a specific subject matter through oral interview and/or attainment of a score of at least 85% on a written test. Testing will be conducted by the Authority or its designee. Personnel required to be qualified by these Specifications must achieve this designation within 45 days after Limited NTP.

59. Quality Assurance (QA): The process by which the Authority elects to monitor and assure that it receives proper construction related documentation from the Contractor. QA procedures measure the setting of schedules for the receipt and review of documentation and the quality of the information contained within the documentation.
60. Quality Control (QC): The process by which the Authority receives documentation from the Contractor that proves that the Contractor is providing the contractually mandated services, such as training, testing and inspection. The Contractor must show evidence of internal procedures demonstrating how he will perform these mandated functions and submit documentation that QC verifications have been completed. QC is the responsibility of the Contractor.
61. Rail: In track, a rolled steel shape, commonly a T-section, designed to be laid end to end in two parallel lines on crossties or other suitable supports to form a track for railway rolling stock.
62. Rail Anchor: A device attached to the base of a rail bearing against a crosstie to prevent the rail from moving longitudinally under traffic.
63. Rail Joint: A fastening designed to unite the abutting ends of contiguous rails. Often referred to as angle bars or joint bars. When rails of different sections are joined, a compromise rail joint is used.
64. Railroad Operators: Any passenger or freight related railroad companies, including Southern California Regional Rail Authority (SCRRA), also referred to as Metrolink, BNSF Railway Company (BNSF), Union Pacific Railroad (UP), the National Railroad Passenger Corporation (Amtrak), or any railroad operating over the SCRRA track(s).
65. Rail Section: Designates and describes a specific size and shape of steel cast and rolled into railroad rail. The rail mills identify the different shapes and types of rails by code numbers, which typically indicate the nominal weight, measured in pounds per yard (3 lineal feet of rail). As example: 136-pound RE section.
66. Relay Rails: Rails taken up from tracks where formerly used, suitable for relaying in other tracks.
67. Railroad Tie: The transverse member of the track structure to which the rails are spiked or otherwise fastened to provide proper gage and to cushion, distribute, and transmit the stresses of traffic through the ballast to the roadbed. Also referred herein as a crosstie.
68. Relocate: Change the location, position or station of an item through removal from existing location and reinstallation of existing equipment to new location. Relocation may involve installation of new connections or accessories.
69. Restricted Speed: A speed that allows stopping within half the range of vision short of: Trains, Engine, Railroad Car, Maintenance of Way Equipment, stop signal, or derail or switch not properly lined.

70. Reverse Curve: Adjoining or nearby curves on a track that turn in opposite directions.
71. Right-of-Way: The real property, inclusive of all estates and interests therein, that is necessary for ownership and operation of the Project. Right-Of-Way, as the term is used in the Contract, specifically excludes:
  - a. Utility easements outside of SCRRRA ROW and,
  - b. Any temporary easements or other real property interests which the Contractor deems necessary or advisable in connection with construction of the Project or Relocations.
72. Roadbed: The foundation upon which the ballast, ties and rails of a railroad are laid.
73. Roadway Maintenance Machine: Any device which is powered by any means of energy other than hand power which is being used on or near railroad track for maintenance, repair, construction or inspection of track, bridges, roadway, signal, communications or electric traction systems. Roadway maintenance machines may have road or rail wheels or may be stationary.
74. Roadway Worker: Any employee of Authority or the Contractor to the Authority, whose duties include inspection, construction, maintenance or repair of railroad track, bridges, roadway, signal and communications<sup>4</sup> systems, roadway facilities or roadway machinery within the Authority right of way.
75. Roadway Worker in Charge (RWIC): The Roadway Worker in Charge designated by the Authority to provide train protection for one or more work groups as per the SCRRRA On-Track Safety Manual for Roadway Workers.
76. Roadway Worker On-Track Safety Manual (or Instructions): When used in these specifications, SCRRRA On-Track Safety Manual for Roadway Workers (OTSM) and Roadway Worker Protection (RWP) Safety Manual will replace all locations where SCRRRA Roadway Worker On-Track Safety Manual (or Instructions) is stated. If a particular section of the old Roadway Worker On-Track Safety Manual (or Instructions) was called out, Contractor shall review the new OTSM & RWP manuals for the updated section reference.
77. Salvage: To save any removed item. The salvaged item shall be reused in the contract or delivered and stockpiled for the Authority as specified in the Contract Documents.
78. Shoofly: A temporary detour track to bypass an obstruction or construction site.
79. Site Specific Work Plan (SSWP): A program, plan, and schedule prepared and submitted by the Contractor and approved by the Authority that accurately describes and illustrates the manner in which Work within the Operating Envelope will be accomplished, the impacts on any elements of the Operating System and the manner in which Work will be accomplished with the Authority allotted Work Windows.
80. Side Track: A track auxiliary to the main track.



81. Siding: A track auxiliary to the main track for meeting or passing trains. See "Passing Track".
82. Special Trackwork: Any trackwork consisting of more than two rails and ties. Examples are turnouts, switches and diamond crossings.
83. Specifications: When this document makes reference to "These Specifications", or to "Site Specific Specifications", or to "Project Specifications", or to "Project Specific Specifications", these terms shall be taken to mean the Project Specifications that describe, in detail, the products, materials, performance and administrative requirements, to execute the work shown in the Contract Documents.
84. Spur Track: As distinguished from a Side Track, a Spur Track is of indefinite length, extending out from the main line.
85. Standard Gage: The standard distance between rails of most North American railroads, being 4' 8-1/2" measured between the inside gauge faces of the rail heads, 5/8 inch down from the running surface.
86. Storage Track: A track on which cars are placed when awaiting disposition or when not in service.
87. Stub Track: A form of sidetrack connected to a running track at one end only and usually protected at the end by some form of bumping post or other solid obstruction.
88. Subballast: Any material spread on the finished subgrade of the roadbed below the ballast to provide better drainage, prevent upheaval by frost, and better distribute the load over the roadbed.
89. Subgrade: The finished surface of the roadbed below the ballast and track.
90. Subgrade Preparation: Preparing the earth surface upon which the subballast and roadbed or other proposed improvements will be placed.
91. Subgroup Coordinator: The Subgroup Coordinator assists the RWIC by overseeing a subgroup of 10+ workers are in a different area or if workers are spread out. The Subgroup Coordinator must have a job safety briefing with the RWIC before any member of the subgroup fouls the track and each time the condition change. The Subgroup Coordinator must use the information received during the job safety briefing with the RWIC to job brief each member of the subgroup. The Subgroup Coordinator must job brief each member of the subgroup before fouling the track and each time conditions change.
92. Superelevation: The intentional difference in elevation between the top of the outer rail and the top of the inner rail measured along a line perpendicular to the track centerline.
93. Switch: A track structure with movable rails to divert rolling stock from one track to another.

94. Switch Angle: The angle included between the gauge lines of the switch rail at its point and the stock rail.
95. Switching: Switching service consists of moving cars from one track to another track or to different positions on the same track. It includes the moving of cars in the make-up and break-up of trains; also moving of cars on industrial switching tracks or interchange tracks, and the general movement of cars within terminals or at junctions.
96. Tamper: A power-driven machine for compacting ballast under ties.
97. Tangent: Any straight portion of a railway alignment. Tangent track means a section of track that connects two curves.
98. Ticket Vending Device (TVD): a vending machine that produces paper or electronic tickets or recharges a stored-value card or smart card or the user's mobile wallet. Also referred to as a Ticket Vending Machine (TVM).
99. Timetable: A publication with instructions on train, engine, or equipment movement. It also contains other essential information.
100. Track: An assembly of rails, ties, rail fastenings, hardware and roadbed over which cars, locomotives and trains are moved and the space between the rails and space of not less than four feet outside of each rail.
101. Track Maintenance Manual: When used in these specifications, SCRRA Track Maintenance Manual (TMM) will replace all locations where SCRRA Track Maintenance and Engineering Instructions is stated. If a particular section of the old TMEI was called out, Contractor shall review the new Track Maintenance Manual for the updated section reference.
102. Track/Ballast Stabilizer: A machine that stabilizes the track by inserting controlled and accurate force directly into the track structure.
103. Truck: The complete assembly of parts, including wheels, axles, bearings, side frames, bolster, brake, rigging, springs and all associated connecting components, the function of which is to provide support, mobility and guidance to the railroad car.
104. Train: An engine or more than one engine coupled, with or without cars displaying markers. For practical purposes, a train is a group of coupled cars hauled by a locomotive.
105. Turnout: An arrangement of a switch and a frog with closure rails by means of which rolling stock may be diverted from one track to another. Also referred to as "track switch."
106. Walkway: A portion of the railroad embankment or ballast section shaped and finished to conform to SCRRA ES2001, ES2002, and CPUC requirements for train employee walking surfaces.

107. Watchman: An Authority or employee contracted with the Authority who has been annually trained and Qualified to provide warning to Roadway Workers of approaching trains or on-track equipment.
108. Wheel: The cast or forged steel cylindrical element that rolls on the rail carries the weight and provides guidance for rail vehicles. Railway wheels are semi-permanently mounted in pairs on steel axles and are designed with flanges and a tapered tread to provide for operation on track of a specific gage. The wheel also serves as a brake drum on cars with on-tread brakes.
109. Wheel Set: The term used to describe a pair of wheels mounted on an axle.
110. Work: The Work, as stated in this document shall be taken to mean the total effort put forth by the Contractor to construct the improvements shown on the Contract Documents.
111. Work Window: A period of time with specific beginning and ending time and durations for which the track, signals, bridges and other Operating System elements within the Operating Envelope are temporarily removed<sup>4</sup> from service or modified in some other manner and train and other operations suspended or modified to allow construction or maintenance work to occur. Written Authority from the Authority and an approved Site Specific Work Plan (SSWP) is required before the Contractor is granted a Work Window. The Contractor's Work Window shall have specific geographic limits, which are defined in the approved SSWP. Modifications or suspension of train and on-track equipment movements resulting from a Work Window involves written changes to the Railroad's Rules of Train and On-Track Equipment Operations. These written changes are known as Track Bulletins and are categorized as follows:
  112. Exclusive Track Window: An approved Work Window in which no train movements (except the Contractor or Authority work trains or equipment under control of the RWIC, per the SSWP) will operate on any track within the window limits. The Contractor may dismantle, remove, reconstruct, or otherwise obstruct tracks within the limits of such a window. This Work may be protected by track out of service, track and time limits, or by Form B Track Bulletin.
    - a. Limited Track Window: An approved Work Window for some, but not all tracks within a general Work area (e.g. one track remains for operation of trains, other tracks are available for the Contractor's Work). Movement of trains over the track(s) of a Limited Track Window is under the control of the RWIC who will not authorize train movement unless and until the Contractor personnel and equipment are clear of the operating track. The Contractor may remove, construct, or obstruct only the track designated by the SSWP and must arrange the Work so that trains can operate without delay on the remaining track(s) in the Work area. This Work may be protected by track out of service, track and time, or by Form B Track Bulletin.

- b. “Form B” Work Window: An approved Work Window in which passenger, freight and all other trains and on-track equipment movements can be prohibited from entering the defined limits of a segment of track. The “Form B” Work Window does not allow the Contractor to remove from service or modify the tracks, signals, bridges, stations or other elements of the Operating System in a manner, which will delay or in any way affect the safe operation of the trains. The “Form B” Work Window allows the Contractor the ability to enter the Operating Envelope and perform construction activities subject to the conditions above. A Roadway Worker in Charge/Flagman from the Authority will exercise strict control over the Contractor’s construction activities in conjunction with Roadway Worker Protection requirements, to assure that the Contractor’s activities do not delay or impact train service.
- c. Track and Time: An approved Work Window in which the Dispatcher will authorize men and equipment to occupy a track or tracks within limits for a certain time period. The Dispatcher authority shall include authority number, track designation, limits and time. Movements may be made in either direction within the specified limits until the limited are released.
113. Work Train: A train engaged in services for the Authority for which no revenue is received, such as trains distributing ballast, bridge material or other material and supplies for maintenance or for additions and improvements.
114. Yard: A system of tracks within defined limits provided for the making up of trains, storing of cars and other similar purposes.
115. Yard Lead: An extended track connecting either end of a yard with the main track.
116. Yardmaster: The person designated as being in charge of all operations in a yard.
117. Yard Office: A building in terminal yards to provide office accommodations for the yardmaster and office personnel.

### 1.03 ABBREVIATIONS

#### A. Association Abbreviations:

AA	Aluminum Association
AABC	Associated Air Balance Council
AIEE	American Institute of Electrical and Electronics Engineers
AAMA	American Architectural Manufacturers Association
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute

ADA	Americans with Disabilities Act
ADC	Air Diffusion Council
AGA	American Gas Association
AGC	Associated General Contractors
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AI	Asphalt Institute
AISC	American Institute of Steel Construction, Inc.
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
APA	American Plywood Association
APWA	American Public Works Association
AREMA.	American Railway Engineering and Maintenance of Way Association
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWPA	American Wood Protection Agency
AWPB	American Wood Preservers Bureau
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BNSF	Burlington Northern & Santa Fe Railway
Caltrans	California Department of Transportation
CBM	Certified Ballast Manufacturers
CCR	California Code of Regulations (formerly California Administrative Code)
CLFMI	Chain Link Fence Manufacturers Institute
CISPI	Cast-Iron Soil Pipe Institute
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
CS	Commercial Standard, US Department of Commerce
CTIOA	Ceramic Tile Institute of America
DHI	Door and Hardware Institute
DOD	Department of Defense (leading symbol
ETL	Electrical Testing Laboratories
Fed Spec	Federal Specification or Standard
FGMA	Flat Glass Marketing Association
FHWA	Federal Highway Administration
FIA	Factory Insurance Association
FSFRA	Federal Specifications Federal Railway Administration
GAFTA	Gypsum Association Federal Transit Authority
ICBO	International Conference of Building Officials
IEEEICBO	Institute of Electrical and Electronic Engineers International Conference of Building Officials

IESIEEE	Illuminating Engineering Society Institute of Electrical and Electronic Engineers
ISOIES	International Standards Organization Illuminating Engineering Society
MIAISO	Masonry Institute of America International Standards Organization
MILMIA	Military Specification or Standard (leading symbol)Masonry Institute of America
MLMAMIL	Metal Lath Manufacturers Association Military Specification or Standard (leading symbol)
ML/SFAMLMA	Metal Lath/Steel Framing Association Metal Lath Manufacturers Association
MSML/SFA	Military Specifications Metal Lath/Steel Framing Association
NAAMM	National Association of Architectural Metal Manufacturers
NBSMS	National Bureau of Standards (now NIST, q.v.)Military Specifications
NECNBS	National Electrical Code National Bureau of Standards (now NIST, q.v.)
NEMANEC	National Electrical Manufacturers Association National Electrical Code
NFCNEMA	National Fire Code National Electrical Manufacturers Association
NFPANFC	National Fire Protection Association National Fire Code
NISTNFPA	National Institute of Standards and Technology (formerly NBS, q.v.)National Fire Protection Association
NLMANIST	National Lumber Manufacturers Association National Institute of Standards and Technology (formerly NBS, q.v.)
NPDESNLMA	National Pollutant Discharge Elimination System National Lumber Manufacturers Association
OSHANPDES	Occupational Safety and Health Administration National Pollutant Discharge Elimination System
PCAOSHA	Portland cement Association Occupational Safety and Health Administration
PSPCA	Product Standard, US Department of Commerce Portland cement Association
RISPS	Redwood Inspection Service Product Standard, US Department of Commerce
SDISAE	Steel Deck Institute Society of Automotive Engineers
SDI	Steel Deck Institute
SFM	State Fire Marshal
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPR	Simplified Practice Recommendations, U.S. Dept. of Commerce
SSPC	Steel Structures Painting Council
SSPWC	Standard Specifications and Plans for Public Works Construction

TCA	Tile Council of America
UBC	Uniform Building Code
UFAS	Uniform Federal Accessibility Standards
UL	Underwriters' Laboratories, Inc.
WCLIB	West Coast Lumber Inspection Bureau
WIC	Woodwork Institute of California
WWPA	Western Wood Products Association

B. Railroad, Agency, and Organization Abbreviations:

ACTA	Alameda Corridor Transportation Authority <sup>4</sup>
Amtrak/LOSSA N	San Diego – San Luis Obispo Rail Corridor
BNSF	Burlington Northern Santa Fe Railway
LACMTA or MTA or METRO	Los Angeles County Metropolitan Transportation Authority
NCTD	North County Transit District
OCTA	Orange County Transportation Authority
RCTC	Riverside County Transportation Commission
SBCTA	San Bernardino County Transportation Authority
SCRRA	Southern California Regional Rail Authority
SDNR	San Diego Northern Railway
UPRR	Union Pacific Railroad
VCTC	Ventura County Transportation Authority <sup>4</sup>

C. Text Abbreviations:

AL	Allowance
AMP or amp	Ampere
AWG	American Wire Gage
CDF	Controlled Density Fill
CF	Cubic foot or feet
CFM or cfm	Cubic feet per minute
CY	Cubic Yard
EA	Each
FPM or fpm	Feet per minute
FPS or fps	Feet per second
Ft. or '	Feet
GPM or gpm	Gallons per minute
in. or "	Inches
Kip or kip	thousand pounds force
Ksi or ksi	thousand pounds per square inch
Ksf or ksf	thousand pounds per square foot
KV or kV	Kilovolt
KVA or kva	Kilovolt amperes

KW or kW	Kilowatt
KWH or kwh	Kilowatt hour
LBS	Pounds
LF or lf	linear foot or feet
LS	Lump Sum
MPH or mph	Miles per hour
PCF or pcf	Pounds per cubic foot
PSF or psf	Pounds per square foot
PSI or psi	Pounds per square inch
SF or sf	Square foot or feet
SY or sy	Square yard
TF	Track Feet
TON	Ton

#### 1.04 REFERENCE STANDARDS

- A. For products or workmanship specified by association, trade, or Federal Standards, the Contractor shall comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. The Contractor shall conform to reference standards by date of issue current as of date of Agreement between the Authority and the Contractor.
- C. The Contractor shall maintain the latest copy of applicable sections of standards at jobsite during submittals, planning, and progress of specific Work, until substantial completion, and shall make the standards available for Engineer's use upon request.
- D. Should specified Reference Standards (those standards listed in the Schedule of References in addition to those codes and regulations specified elsewhere in the Specifications) conflict with the Contract Documents, the Contractor shall request clarification from the Authority before proceeding. If conflict exists, the Specification as determined by the Authority shall apply.

#### 1.05 SCHEDULE OF REFERENCES

- A. AAR Association of American Railroads
- B. ACI American Concrete Institute
- C. AGC Association of General Contractors
- D. ANSI American National Standards Institute
- E. AREMA American Railway Engineering and Maintenance-of-Way Association (Formerly AREA - American Railway Engineering Association) All AREA standards and Manuals not superseded by AREMA standards will remain in effect.
- F. ASTM American Society for Testing and Materials



G.	AWPA	American Wood-Preservers' Association
H.	CALOSHA	California Office of Safety and Health Administration
I.	CALTRANS	State of California Department of Transportation Standard Specifications and Standard Plans
J.	CA MUTCD	California Manual on Uniform Traffic Control Devices
K.	CPUC	California Public Utilities Commission General Orders
L.	CRSI	Concrete Reinforcing Steel Institute
M.	FHWA	Federal Highway Administration
N.	FRA	Federal Railroad Administration
O.	MSHA	Mine Safety and Health Administration
P.	NRMCA	National Ready Mixed Concrete Association
Q.	OSHA	Office of Safety and Health Administration
R.	RTA	Railway Tie Association
S.	TMM	Southern California Regional Rail Authority – Track Maintenance Manual
T.	SSPWC	Standard Specifications for Public Works Construction
U.	USDOT	United States Department of Transportation

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 11 15**

## **SECTION 01 11 16**

### **WORK BY SCRRRA**

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

##### **1.01 SUMMARY**

This section describes the Authority furnished labor necessary to support the Contractor's construction operations. It is the Contractor's responsibility to furnish any and all other labor, materials, and equipment required to complete the work set forth in the Contract Documents, specifically excepting those Authority furnished resources described below and in the Specifications. Authority furnished materials and equipment is shown in Section 01 64 00, SCRRRA Furnished Material & Equipment.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 14 00, Work Restrictions
- B. Section 01 14 16, Coordination with SCRRRA
- C. Section 01 64 00, SCRRRA Furnished Material and Equipment

##### **1.03 REFERENCE STANDARDS**

- A. FRA: Federal Railroad Administration, 49 CFR Part 213, Track Safety Standards, and 49 CFR Part 214, Railroad Workplace Safety
- B. SCRRRA: On-Track Safety Manual for Roadway Workers

##### **1.04 AUTHORITY FURNISHED LABOR**

- A. Authority will provide an Roadway Worker in Charge (RWIC), and 49 CFR Part 213.7 qualified personnel to monitor the interface between the Contractor's work and train movements and facilitate temporary rearrangements or tracks out of service. The Contractor shall include requests for Authority furnished labor in his Site Specific Work Plan (SSWP), which shall be prepared and submitted in accordance with Section 01 14 00 which identifies "Work Restrictions," the Contractor's Responsibilities and Key Definitions for "Operating Envelope," "Operating System," and "Work Windows" to determine the conditions for which Authority furnished labor is utilized. The allocation of the number of Authority furnished RWIC's is subject to the following:
  - 1. Roadway Worker Protection (RWP)

- a. RWP within the Operating Envelope: The Authority will furnish an Roadway Worker-in-Charge (RWIC) for 10.5 hours per day, five calendar days per week, unless specified otherwise in the Specifications, to provide RWP against the movement of any passenger/commuter, freight, work, and all other types of trains and on-track equipment. Refer to paragraph 4.02B herein for the maximum number of RWIC's to be provided by the Authority.
  - b. The maximum shift duration for one RWIC is 10.5 hours. Under "Form B" protection, the 10.5 hours includes 8 hours of the Contractor work (excluding train interruptions) and 2.5 hours to install and remove Form B flags and provide daily job briefings. The Contractor shall not be allowed to work within the Operating Envelope during the 2.5-hour flag installation and removal. The minimum shift duration for flagging services is 4 hours. If the Contractor desires to perform activities requiring an RWIC that are longer than 8 hours' duration, then the Contractor shall coordinate with the Authority to schedule multiple RWIC's for said Work.
  - c. The Contractor shall schedule and establish its work limits within the range of vision of the assigned RWIC. If the Contractor's requested work limits are outside the normal range of vision of the RWIC due to curves, topography, or distance, multiple Subgroup Coordinators will be needed. One Subgroup Coordinator is needed for every 10 roadway workers. The Contractor shall include in the SSWP how many RWIC and Subgroup Coordinators are needed.
  - d. RWP outside the Operating Envelope: The Authority will furnish an RWIC to provide RWP for the Contractor's construction operations that are outside of the Operating Envelope, but within the railroad right-of-way.
2. The Authority does not expressly or by implication agree, warrant, or guarantee that the Contractor's request for additional RWICs will be approved, or that the resources will be available.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 ARRANGEMENTS FOR AUTHORITY FURNISHED LABOR**

- A. As further described in Section 01 14 00, Work Restrictions, the Authority will arrange for an Authority furnished RWIC based upon the approved SSWP.
- B. Contractor shall provide notice of required RWIC's to be provided by SCRRRA 15 days in advance of the Work

## PART 4 - MEASUREMENT AND PAYMENT

### 4.01 MEASUREMENT

- A. Authority provided RWIC 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

Unless provided for otherwise in the Specifications, the Authority shall provide the Contractor the services of RWIC(s) for up to 10.5 hours per day, 5 days per week, at no cost to the Contractor as noted below.

- A. The Authority has determined the RWIC services based on its own calculations and schedule. Authority will provide a maximum of [TBD] days' worth of RWIC. An RWIC day is considered to be one 10.5 hour day, Monday through Friday during the day for up to 10 roadway workers. Work that is additional hours above this, at night, on weekends, or with more than 10 roadway workers will count as additional RWIC's accordingly. The Contractor shall prepare the SSWP based on this information and Authority and Contractor shall agree to the SSWP, including the RWIC shift times and number of RWIC's needed. If the Contractor requires additional RWIC services, the Contractor shall pay for these flagging services. In such a case, the Contractor shall pay for the actual costs of flagging services, as shown in the rate sheet in the link below. RWIC rates are subject to change at any time and may be found on the Metrolink website at:  
[https://metrolinktrains.com/globalassets/about/engineering/scrra\\_schedule\\_of\\_fees\\_for\\_third\\_party\\_construction.pdf](https://metrolinktrains.com/globalassets/about/engineering/scrra_schedule_of_fees_for_third_party_construction.pdf)
- B. If the Contractor cancels scheduled RWIC work and does not make arrangements with the RWIC 48 hours in advance for cancellation, the Contractor shall reimburse SCRRA for the cost of the RWIC. If the Contractor sets up a Form B or other type of protection required to be in the next day's SCRRA Railroad Bulletin, and the Contractor does not work or cancels the RWIC for reasons other than Force Majeure, the Contractor shall reimburse SCRRA for the cost of the RWIC.
- C. SCRRA railway flagging cannot be scheduled until the Temporary Right of Entry Permit has been issued and the SSWP has been agreed upon by SCRRA. SCRRA recommends scheduling SCRRA railway flagging a minimum of 15 working days in advance of work. Work that impacts the SCRRA right of way will not be allowed to be done without SCRRA railway flagging.

The items E-H below are in connection with the below fee schedule posted on SCRRA's website:

[https://metrolinktrains.com/globalassets/about/engineering/scrra\\_schedule\\_of\\_fees\\_for\\_third\\_party\\_construction.pdf](https://metrolinktrains.com/globalassets/about/engineering/scrra_schedule_of_fees_for_third_party_construction.pdf)

- D. SCRRA fees associated with obtaining Roadway Worker Protection (RWP) Safety training class will be paid by [the Project Sponsor] for up to [TBD] classes maximum.
- E. SCRRA fees associated with Signal and Communications line location markouts will be paid by [the Project Sponsor].
- F. SCRRA fees associated with SCRRA standard plan review, SCRRA administration, SCRRA staff time contingency, and SCRRA inspection will be paid by [the Project Sponsor].
- G. Related costs for compliance with all other SCRRA requirements, including but not limited to additional insurance, labor hours related to preparing/obtaining permits, attending training, re-submitting documents if required, delays in obtaining the right-of-entry, shall be considered as included in the prices in the Bid for the various items of work and no additional compensation will be allowed.

**END OF SECTION 01 11 16**

**SECTION 01 14 00**  
**WORK RESTRICTIONS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This Section outlines requirements and provisions for rules and hours of operation for the Contractor execution of the Work under this Contract.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 11 16, Work by SCRRA
- B. Section 01 14 16, Coordination with SCRRA
- C. Section 01 35 15, Maintenance and Protection of Railroad Traffic
- D. Section 01 35 23, Site Safety Requirements

**1.03 REFERENCE STANDARDS**

Comply with the provisions of all local, State, and Federal codes, specifications, standards, industry recommended practices and Authority policy including:

- A. SSPWC: Standard Specifications for Public Works Construction
- B. FRA: Federal Railroad Administration Track Safety Standards, 49 CFR Part 214
- C. SCRRA: Track Maintenance Manual and On-Track Safety Manual for Roadway Workers
- D. SCRRA: Design Criteria Manual, Chapter 15.0, Excavation Support Criteria
- E. Caltrans: Trenching and Shoring Manual
- F. CPUC: California Public Utilities Commission General Orders
- G. CALOSHA: California Occupational Safety and Health Administration regulations
- H. OSHA: Federal Occupational Safety and Health Administration regulations

**1.04 KEY DEFINITIONS**

Some key definitions that pertain to this Section are listed below. Refer to Section 01 11 15 and the Contract General Conditions for more key definitions.

- A. Operating Envelope – A well-defined area determined by the Authority in which Work must be performed with permission.

- B. Operating System – The components of an operating system all exist in order to make the different elements of the system work together.
- C. Work Window – See Section 01 11 15. 1.02 Definition of Terms.
- D. Site-Specific Work Plan (SSWP) – See Section 01 11 15. 1.02 Definition of Terms.

### **1.05 SUBMITTALS**

Provide submittals such as the Site Specific Work Plan (SSWP) in accordance with Section 01 33 00, Submittal Procedures.

### **1.06 PROJECT COORDINATION**

- A. Cooperate with the Authority in all matters requiring coordination for execution of the Work including eliminating or minimizing to the greatest extent possible interference and delays to all scheduled passenger and freight trains movements. Information regarding train movements is available to the Contractor, upon request. A sample activity report of train movements for one week may be obtained from the Authority.
- B. The Contractor shall keep the Authority fully informed regarding any night or weekend Work.
- C. The Authority may require the Contractor to finish a section on which Work is in progress before Work is started on any additional section.
- D. Authority will be conducting work on other contracts at the same time as the Contractor's Work. The Contractor shall coordinate with other contractors and use the same Form B used by other contractors.

### **1.07 CONTRACTOR'S RESPONSIBILITY**

- A. The Contractor shall perform Work in accordance with the Contract and all applicable codes, ordinances, rules, regulations, orders, and other legal requirements of governmental bodies and public agencies having jurisdiction, including the Authority.
- B. Any damage caused by the Contractor to rails, ties, structures, embankment, third-party property, signal and communications equipment, or any other facilities shall be repaired at the Contractor's expense to a condition equal to or better than the condition prior to the Contractor entry, and as accepted by the Authority. At the sole discretion of the Authority, the Authority may direct that repairs be performed by other Contractors. The charges for such repairs shall be deducted from the Contractor's payment due under this Contract.
- C. Items shown on the plans to be protected in place shall be protected in place in accordance with SSPWC, Protection and Restoration of Existing Improvements, at no additional cost to the Authority.

- D. The Contractor shall not perform any work on or adjacent to the Main Track without prior written approval of the Authority. Perform work within the Operating Envelope or which affects the Operating System only after submitting a Site-Specific Work Plan (SSWP) and receiving written approval of the SSWP from the Authority.
- E. Furnish all labor, materials, equipment and other incidentals as required to perform and complete the Work within the Work Windows, in accordance with the approved schedule in the SSWP.

#### **1.08 CONTRACTOR USE OF WORKSITE**

- A. The Contractor shall coordinate access, use, and preparation of facilities adjacent to the Project areas with owners and agencies. Coordination shall include but not be limited to the following:
  - 1. The Contractor shall arrange Worksite access with adjacent property owners for the use of private property, as the Contractor deems necessary for operations.
  - 2. Construction staging plans included in the Contract Drawings represent an Authority approved work plan. The Contractor may submit an alternative staging plan for review by the Authority. The alternative staging plan must be accepted by the Authority prior to the Contractor undertaking any Work in accordance with the alternative staging plans.
  - 3. Fences, walls, signs, and gates affected by the Contractor's access to the Right of Way shall be restored to full serviceability prior to demobilization.
- B. Right-of-Way: All contract work shall be performed within SCRRRA right-of-way unless otherwise stated in the contract documents.
- C. Work on Private Property Other Than Railroad: Any additional easement areas requested by the Contractor shall be obtained by separate contract between the Contractor and the property owner and shall be solely at the Contractor's own risk and expense. The Authority will not be a party to nor assume any liability for those separate contracts. The Contractor shall transmit copies to the Authority of all executed property agreements, easements and contracts with third parties within 3 working days of the execution. The Contractor shall coordinate scheduling of Work to be performed on private property with property owner and property tenant so as to minimize inconvenience to the property owner and property tenant. Contractor can secure additional areas with respective owners at Contractor's own expense and responsibility. The Contractor shall make arrangements, pay for, and assume all responsibility for acquiring, using, and disposing of Work areas and facilities temporarily acquired by the Contractor in addition to those provided by the Authority. The Contractor shall indemnify and hold the Authority harmless for all claims for damages caused by such actions.



- D. Property Rights in Land and Improvements: The Contractor shall make no arrangements with any person or entity to permit occupancy or use of any land, structure, or building within the limits of the Work, for any purpose whatsoever, either with or without compensation, in conflict with any agreement between the Authority and any third-party owner, former owner, or tenant of such land, structure, or buildings.
- E. The Contractor shall confine Worksite operations to areas permitted by law, ordinances, permits, and the Contract.
- F. The Contractor shall consider the safety of the Work, train operations personnel, and property on and adjacent to the Worksite when determining amount, location, movement, and use of materials and equipment on Worksite. The Contractor shall not load Worksite with excessive amounts of material, equipment, or other items that have the potential to interfere with the Work or with train operations. The Contractor shall relocate stored products, equipment, and materials that interfere with train operations, public and private utilities, or visibility at railroad crossings. Materials and equipment shall not be so piled, stored, or parked when not in use.
- G. The Contractor shall adhere to the noise levels and hours of Local Ordinances, except as provided and approved in the Site-Specific Work Plan (SSWP).
- H. The Contractor shall be responsible for coordinating its Work with all property owners affected by the Contractor's operations. The Contractor shall protect the general public and residents within Worksite boundaries from Work-related activities, and shall not unnecessarily inconvenience those persons by Work activities.
- I. The Contractor shall submit the proposed location of staging areas for the Authority's approval.
- J. As necessary, the Contractor will preserve and relocate railroad signs (mileposts, speed limits, "no trespassing" signs, station signs, crossing whistle signs, etc.) during the full period of construction. Signs shall be maintained during construction or restored upon completion of the Work, in accordance with the requirements of Section 01 35 23, SCRRRA Site Safety Requirements. The Contractor shall protect at-grade crossing warning signs and shall coordinate the schedule for relocation or revision of Crossing warning signs and signals by Others, if necessary.
- K. The Contractor will preserve drainage facilities throughout the duration of the Work so that there is no pending or accumulation of water in any Worksite area, there is no flow of water diverted toward the track or out of normal drainage channels, and all culvert inlets and outlets are kept free of debris.
- L. Except where specifically designated in the design of the Work, the Contractor will preserve the ability of maintenance Contractors to access the Right of Way using highway vehicles. If the original right-of-way roads become blocked with the Contractor's materials, equipment, or excavations or spoils, alternate routes must be arranged.

- M. The Contractor will preserve existing right-of-way fences and walls, and will replace any such fences or walls damaged during the work to the satisfaction of the owner(s) of the fences or walls.

### **1.09 WORK ZONE LIMITATIONS OF SITE**

- A. In addition to site utilization limitations and requirements indicated on Contract Documents, the Contractor shall coordinate available space with the Authority and other entities needing access and space so as to produce the best overall efficiency in performance of the total Work of the Project.
- B. The Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site, with minimal disruption to the adjoining site owners and operations. Pick-up and delivery requiring vehicular traffic adjacent to tracks shall be performed only during normal working hours, and as approved by the Authority.

### **1.10 WORK WINDOWS**

- A. The time limits for all types of Work Windows include the time for the Contractor to restore and test the signal and communication system before the operation of trains; therefore, the full duration of the Work Window is not available for the use of the Contractor. The SSWP shall designate both the time at which the Contractor must make the track ready (in full compliance with the FRA Track Safety Standards and with the Authority's Track Maintenance Manual) for the passage of trains, and the remaining time within the Work Window that will be required for the signal and communications system restoration. The SSWP shall be prepared and submitted in accordance with the Work Window requirements shown in the Project Specific Specifications.
- B. The Contractor's Railroad Construction Project Manager or the Railroad Track Construction Manager shall personally inspect the track within the Work Window prior to the restoration of train service; confirm with the Authority that the track is in full compliance with the above standards and establish the speed at which trains will operate upon restoration of the service.
- C. The Contractor does not have exclusive rights to the Work Windows. The Contractor may have to share these Work Windows with other Contractors and the Authority's maintenance forces as described in the General Conditions.
- D. The Contractor shall not perform any fieldwork during three annual designated holidays. Fieldwork shall not include receipt or delivery of materials or equipment or work performed in field offices. The designated holidays are Labor Day, Thanksgiving Day and Christmas Day.
- E. Contractor shall not work on state holidays, federal holidays, nights, or weekends without prior approval of the Engineer.

During these periods, the Authority will not have the resources (labor and equipment) or construction management personnel to issue track bulletins or to support, inspect, or oversee the Contractor's Work.

**1.11 SSWP – GENERAL CONTRACTOR REQUIREMENTS**

- A. All work with the potential to impede the normal functioning of any part of the Operating System shall include a detailed SSWP's showing schedule of events, indicating the expected hourly progress of each activity that has duration of one hour or longer. The schedule shall include a time at which each activity planned under the SSWP and the requested Work Window will be completed, and the total duration of all the construction activities shall be less than the approved Work Window. Failure of the Contractor to complete the scheduled activities by the planned time or to put in place an approved contingency plan may adversely affect the operations of scheduled trains.
- B. The Contractor shall refer to SCRRA's Site Specific Work Plan Scope of SSWP prior to submitting SSWP. The Contractor shall submit SCRRA's SSWP Checklist.
- C. The SSWP shall include at minimum the information specified below.
  - 1. The SSWP shall include scope, brief schedule, location, equipment, material and staging, schedule, haul routes, safety plan, contingency plan, worksite representative, emergency response plan, excavation plan, boring and jacking plan, drilling and pile driving plan, falsework plan, and temporary traffic control plan.
  - 2. All activities necessary to perform construction activities within the Operating Envelope, including use of stations, tracks, signals, proposed storage areas and any other railroad facility.
  - 3. A description of any proposed changes in the Operating System between start and finish of the work, including any requested Work Windows.
  - 4. A schedule of the work, showing each activity and where and how it affects normal operation of the Operating System. This schedule shall integrate and allow for the necessary work of the Signal and Communication forces. Each activity in the plan shall include all labor, materials, and equipment required to complete the activity within the Authority allotted time period. The Contractor shall identify on the schedule all Authority furnished labor, equipment and materials.
  - 5. The Contractor shall have Authority approved Contingency plans for putting the Operating System back in operation in case of an emergency, or in case the Contractor fails to perform and complete the work on time. The contingency plans shall address the various stages of activities necessary to restore the System.
  - 6. List all of the approved proposed work plans to be performed under the SSWP and provide the name(s) and number(s) of the Contractor's supervisor(s) in charge of the SSWP tasks.
- D. The SSWPs must be of sufficient detail, clarity, and organization to permit easy review and approval by the Authority before the proposed work is performed.

The SSWP shall be submitted and approved prior to starting work. The Contractor shall anticipate obtaining approvals from the Authority as follows:

1. At least 14 calendar days prior to start of the work within the Operating Envelope for work other than signal or third-party activity.
  2. At least 30 calendar days prior to the start of work for work involving signal or third-party installation.
- E. The Authority may request explanations and changes to the SSWP to conform the SSWP to the requirements of the Contract Documents. If the SSWP is not acceptable, the Contractor shall revise the SSWP to make it acceptable. The Contractor is responsible for submitting a revised SSWP that can be reviewed and approved by the Authority at least seven days in advance of any work that affects the Operating System.
- F. The Contractor will be informed if the SSWP is acceptable not less than seven calendar days prior to the scheduled start of work within the Operating Envelope. Once the plan is accepted, the Contractor shall assemble the resources necessary to perform the work represented by the SSWP, so that necessary resources are available one calendar day before the work is to be accomplished, thereby demonstrating to the Authority the readiness of the Contractor to perform the Work. At this time, the Authority will make a final decision as to whether or not the Work is to proceed as planned or be canceled.

#### **1.12 SSWP – SPECIAL CONTRACTOR REQUIREMENTS**

- A. The Contractor's construction activities that affect the Operating System including tracks, grade crossings, bridges, stations, public highways, and related facilities in active service shall be subject to the following requirements:
1. The Contractor shall provide sufficient personnel, equipment, materials, and all other resources necessary to return the affected facilities to full service upon the conclusion of the approved "Work Window."
  2. The Contractor shall perform the Work expeditiously and continuously, with no gaps or breaks in the work activities or substantive reductions in the labor force, equipment, and materials necessary to construct, reconstruct, or repair the affected facility to full service upon the conclusion of the approved "Work Window."
  3. The size and scope of the affected facilities within the Operating System, (e.g., tracks, bridges) removed shall not exceed the Contractor's capacity to conservatively return the facility to the required level of service within the approved "Work Window."

4. The Contractor shall take all appropriate and reasonable measures to perform work activities and tasks located outside of the Operating System to effectively reduce the amount of time and effort required during the approved "Work Window." These appropriate and reasonable measures shall include but not be limited to preconstruction and preassembly of track turnouts, panels, and pre-staging of track materials and equipment at work sites.
  5. Backup or Emergency Plan: The Contractor shall include in the SSWP a "backup or contingency" plan and the necessary resources (labor, equipment, materials, etc.) to assure the Authority that all appropriate and reasonable measures are available for the return of the affected facility to full service upon conclusion of the approved "Work Window."
  6. When not in use, materials and equipment shall not be piled, stored, or parked, closer than 20 feet horizontally from the centerline of the nearest operating track, or within 250 feet of an open public grade crossing.
  7. The placement of piles, forms, braces, shoring, false work, excavation, or other construction supports shall be in accordance with the current Authority shoring requirements. Temporary overhead structures shall be a minimum of 22 feet 6 inches above top of rail in accordance with CPUC requirements. Temporary overhead structures less than 22 feet 6 inches above top of rail must have an exemption, in advance from the CPUC, and approval of the Authority.
  8. In general, open excavation areas shall be protected per Cal/OSHA regulations and by walkways with handrails no closer than 8 feet 6 inches horizontally from the nearest operating track, if tangent, and 9 feet 6 inches if the track is curved. Furthermore, the walkways shall be no less than 3 feet wide, and the handrails shall be no less than 3.5 feet high and capable of withstanding 250 pounds of lateral force.
- B. Specifically, with regard to track construction, reconstruction, and rehabilitation activities involving active tracks, the Contractor shall be subject to the following requirements:
1. Track construction and reconstruction activities involving main track Operating System shall be limited to what the Contractor could reasonably accommodate, given the Contractor's capability and Authority furnished resources. The Contractor must fully complete all work within an approved SSWP segment, including all spiking, anchoring, surfacing to final line and grade, dynamic stabilizing, distressing, and welding before initiating Work on another location within the Project limits.
  2. All turnouts installed on active tracks shall be constructed and installed as panels. All turnout panels shall be fully complete and inspected and approved for installation by the Authority two weeks prior to the scheduled installation.

3. At all times, the Contractor shall maintain an adequate quantity of ballast to finish the next two weeks of track construction activities requiring ballast. This stockpile shall be provided as approved in the Contractor staging plan so that it is in close proximity to the Work site, or in rail cars under load.
4. The Contractor shall use a dynamic track stabilizer on all tracks that have been significantly disturbed (i.e., ties or ballast removed).

### 1.13 TRACK BACK IN SERVICE

- A. At the end of each Work Window shown in the approved SSWP, the Contractor shall return all tracks to Class 5 as defined by FRA guidelines. If the track does not meet Class 5 specifications, a slow order (Form A) will be issued. It is the intent of the Contract Documents that Main Line Slow Orders only be allowed on a very limited basis. See Section 01 35 15, Maintenance and Protection of Railroad Traffic, or the Specifications for the number of allowed speed restrictions.
- B. The time of train delays caused by the Contractor's operation will be calculated as in Section 01 35 15, Maintenance and Protection of Railroad Traffic. The Contractor shall include all slow order (Form A) requests in his proposed SSWP. All slow orders shall be subject to the approval of the Authority.
- C. The Authority will require final inspection before train service can resume on tracks previously taken out of service.
- D. Allowing train service on reconstructed or shifted track at the end of each approved Work Window is not considered beneficial occupancy or final acceptance. The Contractor shall remain fully responsible for any loss or damage arising from the Contractor's activities under this Contract.
- E. If further adjustments or repairs are required to provide the appropriate track standards as defined herein, the Contractor shall, immediately perform the necessary work at no additional cost to the Authority. In the event the Contractor is not available to make the appropriate adjustments or repairs, SCRRA Maintenance Forces will complete the Work and the Contractor will be responsible for all associated direct and indirect costs, as well as any time associated with such adjustments or repairs.
- F. Rail Service Interruptions shall be considered an unauthorized delay to the Authority's train operations, and Rail Service Interruption Assessments will be made in accordance with the Special Conditions when any of the following occurs:
  1. The Contractor's construction operations exceed the approved Work Window time limits specified in an approved SSWP.
  2. The Contractor exceeds the total allowable Slow Order Delay Time described in Section 01 35 15, Maintenance and Protection of Railroad Traffic.

3. The Contractor exceeds the maximum number of Slow Orders as prescribed in Section 01 35 15, Maintenance and Protection of Railroad Traffic.
4. The Contractor's construction operations working under an approved Form B Work Window result in the stoppage of a scheduled train. In this case, the delay shall be calculated from the time the train is stopped at the working limits until the train has completely passed through the working limits.
5. The contractor has not restored the track to Class 5 standards

#### **1.14 INSPECTION PRIOR TO PLACING TRACK BACK IN SERVICE**

- A. The Contractor shall have qualified personnel at each distinct work site to ensure that all tracks are constructed to the required specifications. The Contractor shall perform a track inspection and determine its classification and conformance with the approved SSWP.
- B. The Authority shall furnish staff for the final inspection required in order to place track and bridge facilities in service for the Authority's use at the end of the Work Window.
- C. The Contractor shall schedule his operations to allow for the necessary inspection and any remedial work required in order to place the tracks and signal system back in service at the prescribed time.
- D. If the track does not meet Class 5 standards due to track or bridge construction irregularities (e.g. gage, distressing, cross level, surface, profile, alignment, improper CWR temperature, loose fasteners, missing components), the track will be slow ordered to the next lower class with which it complies (according to the FRA guidelines).
- E. The Authority reserves the right to have its Maintenance Contractor perform remedial work to return the track to Class 5. In addition to the assessment cost noted in the paragraphs above, the costs to perform the remedial work will be deducted from the Contractor's progress payment.
- F. No additional time will be allowed for completion of the work in the event that the Authority is required to perform the remedial work to return the track to Class 5.

#### **1.15 WORKS BY OTHERS**

The Contractor may be required to interface with other contractors, utility companies, public agencies, private companies, and railroad forces. This interface shall be provided in accordance with the General Conditions and Section 01 14 16, Coordination with SCRRRA. In addition, routine or emergency maintenance of existing Authority facilities may occur during the progress of the Work. Such activities shall have priority and the Authority shall make efforts to minimize interference where possible.

**1.16 RULES FOR WORKING WITHIN RIGHT-OF-WAY**

- A. The Contractor's and SubContractor's employees must be qualified under the current SCRRRA Roadway Worker Policies and 49 CFR 214, Railroad Workplace Safety, before being permitted to work on the right-of-way.
- B. The Authority RWIC will conduct job briefings as required under the Roadway Worker Policy Manual at the following intervals:
  - 1. Start of every work shift
  - 2. Every change of conditions affecting Roadway Worker safety during a work shift
- C. The Contractor shall immediately execute all verbal and written directives of the Authority or the Authority RWIC.
- D. Refer to Section 01 14 16, Coordination with SCRRRA, for rules governing Work adjacent to active tracks.
- E. Unless otherwise specified in the Specifications, Authority RWIC services are required for all Work on railroad right-of-way.
- F. Refer to Section 01 35 23, Site Safety Requirements, and the SCRRRA Roadway Worker Protection Regulations, incorporated as Section 214.3 of the SCRRRA *On-Track Safety Instructions*, for any clarifications or additional requirements.

**1.17 HOURS OF OPERATIONS**

- A. Refer to Project Specific Specifications for allowable Work Windows with the Operating System.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)****PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 14 00**



**SECTION 01 14 16**  
**COORDINATION WITH SCRRRA**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This Section outlines the requirements for coordination with the Authority and related railroads for Work performed on the railroad right-of-way.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 11 16, Work by SCRRRA
- B. Section 01 14 00, Work Restrictions
- C. Section 01 35 15, Maintenance and Protection of Railroad Traffic
- D. Section 01 35 23, SCRRRA Site Safety Requirements

**1.03 REGULATIONS FOR WORKING WITHIN RAILROAD RIGHT-OF-WAY (ROW)**

- A. Upon award of this Contract Work, the most current edition of each of the following publications shall apply to the Contractor's work. The Contractor shall comply with all requirements from the Railroad Operators, CPUC, FRA and all other governing entities. These requirements may include the following:

SCRRRA	Safety and General Rules for All Employees
SCRRRA	Roadway Worker Protection (RWP) Safety Manual
SCRRRA	On-Track Safety Manual for Roadway Workers
SCRRRA	Bridge Worker Safety
SCRRRA	Track Maintenance Manual
SCRRRA	Engineering Standards
SCRRRA	Regulation Governing Contractors and Others Working on SCRRRA Property
SCRRRA	Maintenance of Way Operating Rules
SCRRRA	Maintenance of Way Safety Rules
SCRRRA	Current Timetable
SCRRRA	Current Schedule of Trains

SCRRRA	Form 37, Rules and Requirements for Construction on SCRRRA Property
SCRRRA	Excavation Support Criteria
AMTRAK	Current Schedule of Trains
CPUC	General Orders 26D and 118
FRA	Track Safety Standards: Title 49 CFR 2134
FRA	Roadway Worker Standards: Title 49 CFR 214
GCOR	General Code of Operating Rules

- B. In addition, the Contractor shall comply with the most current edition of the *AREMA Manual for Railway Engineering* for standards of construction not fully explained by the above regulations or these Specifications. Possible conflicts between publications identified in this Section shall be brought to the attention of the Authority, who will make a determination as to the direction that the Contractor should follow.
- C. In the event additional Work is being performed by others, on or adjacent to the Worksite for this Contract, the Contractor shall coordinate the Work with other activities in order to avoid conflicts.

#### 1.04 COORDINATION

- A. All Work within or adjacent to the Authority's Right-of-Way shall, at a minimum, meet the above regulations and be coordinated through the Authority. The Contractor shall cooperate and coordinate the Work as necessary in the most efficient manner for the execution and completion of the Work. If there is a conflict between SCRRRA and other railroad's Rules and Regulations, the Contractor shall follow the Authority's direction as to which set of rules shall prevail. The Contractor shall coordinate its work, so it does not interfere or otherwise delay the work performed by SCRRRA's forces.
- B. Track will be used both for passenger and freight operations. The Authority dispatches all train traffic. The Contractor's Work shall be scheduled to provide minimal interference with all train traffic; in particular, Work will not be permitted to delay any trains. Requirements for slow orders through Work zones are contained elsewhere in these Specifications.
- C. The Contractor activities shall not delay any trains except as approved in advance by the Authority.
- D. The Contractor should participate in the jobsite visit prior to submittal of bids to assess the level of train activity. Some schedule variations should be anticipated during the Project due to normal growth and train schedule refinement by the Authority and other operators.
- E. Authority RWIC will obtain track Authority directly from the Authority dispatcher. The Contractor shall not coordinate with the Authority dispatcher.

- F. Signal cutover work, if any, will be performed by the Contractor.
- G. The Contractor's work shall be coordinated with the Authority in accordance with Section 01 14 00, Work Restrictions, which establishes procedures and lead times required for Authority provided labor, including RWIC.
- H. The Contractor must make arrangements to remove all on-track equipment from the Main Track in order to pass trains as specified in Section 01 14 00, Work Restrictions. The Contractor may not assume that its equipment can be placed or stored in spur tracks or sidings unless approved in advance by the Authority.

#### **1.05 GENERAL REQUIREMENTS**

- A. The Contractor shall obtain permission in writing from the Authority for movement of equipment on track or across tracks at locations other than public crossings. Such permission may not necessarily be granted. If it is granted, the Contractor shall comply with any condition required such as, but not limited to, the bridging of rail and protection of ballast section. Damages to the track structure will be repaired at the Contractor's sole expense.
- B. The mainline tracks, within the limits of Work, are under direct control of the Authority Dispatcher. No track shall be fouled without authorization and presence of an Authority RWIC on the scene.
  - 1. For all Work with the potential to foul the track, the Contractor shall allow sufficient time in his work schedule for the RWIC to clear trains. Up to 15 minutes may be required for the RWIC to clear each train, during which time the Contractor must not foul the track. Such time required to clear scheduled trains shall not be an acceptable reason for submitting contract change requests or delay claims to SCRRRA.
  - 2. Scheduled trains may run behind schedule, and such tardiness will not be an acceptable reason for submitting Contract change requests or delay claims to SCRRRA.

#### **1.06 WORK AFFECTING THE EXISTING COMMUNICATIONS AND SIGNAL SYSTEMS**

- A. Track within the Work limits will be in use for high-speed freight and passenger train operations throughout the construction period. Train movements are governed by signal systems and the Contractor shall take no action which would:
  - 1. Directly or indirectly result in an unsafe condition (e.g., false clearing of a signal, failure to detect train occupancy or an open switch point, unauthorized unlocking of a switch, failure to activate a highway grade crossing warning system, or any degradation of signaling system).
  - 2. Cause delay to any train (e.g., display of a signal aspect less permissive than track conditions allow, obstruction of right-of-way).
  - 3. Cause an improper activation or deactivation of a highway grade crossing warning system.
  - 4. Be contrary to directions given by the Authority or the Authority Dispatcher.

- B. Existing overhead and buried communications and signaling cables and track wires are located at various locations along and across the Right-of-Way. The Contractor shall take all steps necessary to protect active cabling from damage during the Work. Specific utilities associated with the Work of this Contract are detailed in the Plans and Specifications. The minimum precautions to be taken by the Contractor to protect communications and signaling cables are as follows:
1. All personnel working in the vicinity of communications and signaling equipment and cabling shall be instructed by the Authority in proper procedures for working around such equipment. Any Contractor personnel found not to be taking proper precautions will be barred from the Work site.
  2. At least 14 days before performing any excavation Work, the Contractor shall contact the Authority to schedule a signal department mark-out. The Contractor shall call the SCRRRA's "Call Before You Dig" number prior to commencing work at (909) 592-1346 during normal business hours. In case of emergencies involving SCRRRA signal or communication facilities, the Contractor shall call (888) 446-9721. The exact location of communications and signaling cables shall be determined by a careful examination of site and hand potholing. The Contractor may utilize a search coil to determine the general vicinity of buried cabling. All such aforementioned locating activities shall be performed in the presence of the Authority.
  3. It is the responsibility of the Contractor to make arrangements directly with utility companies involving the protection, encasement, reinforcement, relocation, replacement, removing or abandonment in place of non-railroad facilities affected by the Project. SCRRRA has no obligation to supply additional SCRRRA right-of-way for non-railroad facilities affected by this Project, nor does SCRRRA have any obligation to permit non railroad facilities to be abandoned in place or relocated on SCRRRA's right-of-way. Any facility or utility that crosses SCRRRA right-of- way must be covered under an agreement or license obtained through SCRRRA including, without limitation, any relocation of an existing facility or utility.
  4. SCRRRA will, if required, rearrange its communications and signal lines, grade crossing warning devices, train signals, tracks and facilities that are in use and maintained by SCRRRA forces in connection with its operation. This work by the SCRRRA will be done by its own forces or by contractors under a continuing contract and is not a part of the work under the Contract for the construction of the Project. The Contractor must allow sufficient time in its schedule to permit SCRRRA to issue the necessary task orders to its contractors order material, and perform any necessary work.
- C. All communications and signaling cables proximate to the Work shall be physically located by means of potholing with hand tools. Excavation by hand tools shall be done by skimming soil in small increments, rather than by digging straight down with the point of a shovel. All such locating activities shall be performed in the presence of the Authority. Excavation by machinery will be allowed only where the preceding precautions have been taken, as approved by the Authority, to ensure that existing cabling is not at risk of being damaged.

- D. Where the placement of existing cabling interferes with placement of track work, or where cabling is at risk of damage from track work, the Contractor shall request such cabling be relocated or protected by Authority forces.
- E. The relocation of cables may require delays of up to 72 hours after the Authority has been notified of conflicts. Such delays will not be grounds for the Contractor submitting a claim for extension of the Contract Time. The Contractor shall coordinate its work so it does not interfere or otherwise delay the work performed by SCRRA's forces.
- F. The relocation of active cable will be performed by Authority forces.

#### **1.07 WORK AFFECTING EXISTING POSITIVE TRAIN CONTROL (PTC)**

- A. Train movements are governed by Positive Train Control (PTC), which are GPS-based safety systems that combine wireless radio and computing technology. Onboard technology will active safety features that interact with a Back Office Server (BOS) System.
  - 1. Contractor shall perform all work described within these Specifications and Contract Plans in accordance with SCRRA's Positive Train Control Configuration and Change Management Policy (CCMP). The Contractor shall coordinate all CCMP requirements with the SCRRA Engineer.
  - 2. All project related work requiring CCMP compliance shall be scheduled by the Contractor at least sixty (60) calendar days prior to the Contractor performing the work. Once CCMP related work has been scheduled, any schedule changes will require that the initial sixty (60) calendar day requirement be met from the time the work is rescheduled. Any schedule delays incurred through the Contractor's actions will be at the sole expense to the Contractor.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 14 16**

## SECTION 01 14 19

### COORDINATION WITH UTILITIES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section outlines requirements and provisions regarding the Contractor responsibility for coordination with all utility companies to ensure that all utilities are clearly marked, protected for the duration of the construction activities or relocated. The exhibit to this Specification Section entitled Project Utility Responsibilities when included in the Project Specific Specifications shall identify each of the utilities affected by the Work.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 33 00, Submittal Procedures

##### 1.03 SUBMITTALS

- A. Where required by the Contract Documents, the Contractor shall prepare Shop Drawings showing existing utility information and the installation of any utility protection facilities or features to be established on the site prior to initiating construction, maintained for the duration of construction and removed upon completion of construction. This submittal information to the local utility and to the Authority shall identify all necessary Work to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction.
- B. The Contractor shall coordinate with all Utilities and authorities having jurisdiction over these facilities and shall remove and relocate existing utilities and equipment whenever an existing installation interferes with new construction. Carefully examine each location and make arrangements in advance with the Authority to ensure that construction has a minimum impact on the daily operations of the Authority.
- C. Where required by a utility owner or an authority having jurisdiction over an underground facility, within 15 calendar days of the effective date of the Limited Notice to Proceed, the Contractor shall submit a "Potholing Plan" consisting of a plan, schedule, and sequencing to identify and investigate by vacuum potholing all underground utilities and facilities. The Authority will review and comment on the plan within 10 calendar days of receipt.
- D. The relocated utilities shall be specifically identified in the record documents. The types of material and methods of relocation and reconnection of utilities shall match the existing unless otherwise noted.
- E. The Contractor shall furnish the Authority copies of all utility required permits or approvals obtained prior to starting Work at or adjacent to the utility facilities.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 GENERAL**

Prior to the start of Construction, the Contractor shall engage an underground utility detection company to detect and locate all existing underground utilities within the Work. All underground utility information, including the approximate depth, shall be clearly marked on surface and existing pavement for reference. The information shall also be recorded in the Project files. Before commencing work, the Contractor shall notify Dig Alert at 811 or 1-800-422-4133, 72 hours in advance of excavation and advise the Authority of Dig Alert Identification number two working days before excavation begins. Before commencing work, the Contractor shall also notify utility companies which have underground facilities within the limits of the Work, but which do not participate in Dig Alert (e.g. UPRR Dig Ticket, CBUD 1-800-336-9193), in accordance with each utility's notification requirements, and have them locate and mark the facilities within the area of excavation. The Contractor shall keep marking current in accordance with the requirements of Dig Alert and the other utility companies.

SCRRA is not a member of Underground Service Alert (DigAlert) and SCRRA signal and communication lines must be located by contacting the SCRRA Signal Department. Refer to Section 01 14 16, Coordination with SCRRA for additional details.

**3.02 POTHOLING FOR SUBSURFACE UTILITIES AND FACILITIES**

Where required by a utility owner or an authority having jurisdiction over an underground facility, within 30 calendar days of the effective date of the Limited NTP and after Authority's approval of the Contractor's "Potholing Plan", the Contractor shall mobilize not fewer than two (2) separate potholing crews. These two or more potholing crews will work on a continuous basis to identify, locate and verify the location of underground utilities at all project locations. It is the Contractor's responsibility to submit the Potholing Plan and obtain the Authority's approval within this time period.

Potholing and subsurface utilities and facilities verification work shall be completed at least 30 days in advance of any excavation work within the limits of any construction. The intent of performing potholing and field verification of underground utilities well in advance of any relocation, protection or modification of utilities is to preclude any delays or disruption arising from utility relocation and allow for redesign and reissuance of plans and related Contract Documents. Accordingly, any failure on the Contractor's part to perform the potholing and field verification of utilities within the time frames listed above shall be sufficient cause to reject any claims by the Contractor for delays associated with utility relocations.

**3.03 CONTRACTOR FIELD WORK REQUIREMENTS**

- A. The Contractor shall provide personnel, equipment, temporary facilities, construction materials, tools, and supplies at the Work site at the time they are scheduled to be required for general utility location and protection requirements subject to the following requirements:

1. The Contractor shall pothole and physically locate all utilities under Traffic/Pedestrian gate footing or within 2 feet of Traffic/Pedestrian gate footing.
  2. The Contractor shall notify the Gas Utility when excavating within 5 feet of any natural gas pipeline and schedule Utility personnel if required. The Contractor shall hand-dig within 5 feet of any natural gas pipeline.
  3. The Contractor shall notify pipeline owner when excavating within 5 feet of any oil pipeline and schedule standby personnel if required. The Contractor to hand-dig within 5 feet of any oil pipeline.
  4. The Contractor shall notify the Utility providing electrical service when excavating within 5 feet of any energized electric facilities and schedule utility personnel as required. The Contractor to hand-dig within 5 feet of any energized electric facilities.
  5. The Contractor shall hand-dig within 3 feet of any telephone, cable television or fiber optic facilities.
  6. The Contractor shall pothole all utilities under or within 2 feet of a Traffic/Pedestrian gate to confirm depth and lateral location.
  7. Contractor is to comply with all requirements by Utility which may be more stringent than described herein.
- B. Utilities and pipelines, unless otherwise indicated, shall be in operation during the construction work. The safe and proper handling of the utilities and pipelines is the responsibility of the Contractor. The Contractor shall be liable for any injuries, line breakage, damage to the line and damage to property. In addition, Contractor shall be responsible for and shall reimburse Authority or owner of the utility, or pipeline for all damages during construction and for any product (gas, oil or service) lost there from. Precautions must be taken to contain any possible oil spills. Any spillage of gas or oils shall be contained and if the material is not contained and causes damages or gets into natural drainage courses, the Contractor shall be solely responsible. Failure to respond within a reasonable time frame (herein defined as a maximum of four hours or sooner for emergencies as determined by the Authority or the Utility) will constitute cause for Authority to restore such utility damages and to deduct all costs of restoration from the next Progress Payment to the Contractor.
- C. At Limited NTP or the project kick-off meeting, the Authority shall provide contact numbers for all entities to be contacted in case of emergency including signal and grade crossing problems and signal and communications cable locations. This will include the Authority's Chief Dispatcher and the Metrolink Sheriff's Dispatcher. The Contractor shall ensure that Work Site personnel have immediate access to these contact numbers.



**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**EXHIBIT**

**PROJECT UTILITY RESPONSIBILITIES**

UTILITY RELOCATIONS/REARRANGEMENT

REFERENCE SPECIFICATION SECTION: \_\_\_\_\_

CONTACTS AND RESPONSIBILITIES

**Name of Utility:**

**Contact Person:**

**Address:**

**Phone:**

**Email:**

PERFORMANCE RESPONSIBILITY

PAYMENT RESPONSIBILITY

Design done by: \_\_\_\_\_

\_\_\_\_\_

Construction by: \_\_\_\_\_

\_\_\_\_\_

Inspection by: \_\_\_\_\_

\_\_\_\_\_

Yes  No – Third Party Coordination and paid by:

NOTES:

**END OF SECTION 01 14 19**

## **SECTION 01 21 00**

### **ALLOWANCES**

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

##### **1.01 SUMMARY**

This Section includes administrative and procedural requirements governing allowances. Certain items are specified in the Contract Documents by allowances which are established in lieu of additional requirements and to defer selection of actual materials, products or equipment to a later date when direction will be provided to the Contractor. If necessary, additional requirements will be issued by Change Order. Allowances may be stated as unit prices or as lump sum amounts, as noted herein. Approval of final quantities required and the basis for acceptable pricing for items specified by an allowance shall be the sole responsibility of the Authority prior to payment.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 22 00, Unit Prices
- B. Section 01 22 05, Lump-Sum Prices

##### **1.03 SELECTION AND PURCHASE**

- A. At the earliest practical date after award of the Contract, advise the Authority of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. When specified or at the Authority's request, obtain proposals and prepare detailed pricing for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by the Authority from the designated supplier

##### **1.04 ACTION SUBMITTALS**

Submit proposals for purchase of products, equipment, facilities, systems or for payment of services included in allowances, in the form and detail specified for Change Orders. The Authority will review the Contractor's information relevant to the proposed price including all pricing documentation supporting quotations from vendors, calculations, estimating factors, risk analyses, equipment rates, productivity, as well as any other items reasonably required by the Authority to satisfy itself as to the reasonableness of the Contractor's assumptions used to determine price.

##### **1.05 INFORMATIONAL SUBMITTALS**

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in the same manner as for other portions of the Work.

#### **1.06 LUMP SUM, UNIT COST, AND QUANTITY ALLOWANCES**

- A. Allowances shall include the cost to the Contractor of specific products and materials ordered or selected by the Authority under the allowance, and shall include taxes, freight, and delivery to the Project site.
- B. Unless otherwise indicated, the Contractor's costs for receiving and handling at the Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered or selected by the Authority under the allowance shall be included as part of the Contract Price and not part of the allowance.
- C. Whenever the actual cost of the materials, products, or equipment selected by the Authority is more than or less than the allowance amount, the Contract Price will be adjusted accordingly by Change Order.
- D. Unused Materials: After installation has been completed and accepted, return unused materials purchased under an allowance to the manufacturer or supplier for credit to the Authority or if requested by the Authority, retain and prepare unused material for storage by the Authority. Deliver unused material to the Authority's storage space as directed.
- E. Quantity allowances include all costs of materials, labor, equipment, overhead, profit, all taxes, and all other charges for the work. In the event a lesser or greater quantity of the item or work described is used in the Work, the Contract Price shall be adjusted in accordance with the unit prices described in the Schedule of Quantities and Prices.

#### **1.07 CONTINGENCY ALLOWANCES**

- A. Use the contingency allowance only as directed by the Authority for the Authority's purposes, and only by Change Orders that indicate amounts to be charged to the allowance.
- B. The Contractor's overhead, profit, and related costs for products and equipment ordered by the Authority under the contingency allowance are included in the allowance and are not part of the Contract Price. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
- C. Change Orders authorizing use of funds from the contingency allowance will include the Contractor's related costs in accordance with the Changes Section of the General Conditions.
- D. At Project closeout, credit unused amounts remaining in the contingency allowance to the Authority by Change Order.

**1.08 ADJUSTMENT OF ALLOWANCES**

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between the purchase amount and the allowance, multiplied by a final measurement of work-in-place (where applicable). If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
- B. Include installation costs in the purchase amount only where indicated as part of the allowance.
- C. If requested, prepare an explanation and documentation to substantiate the distribution of margins claimed.
- D. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit cost allowances. The Authority reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- E. Submit requests for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or the Contractor's handling, labor, installation, overhead, and profit in accordance with the Changes Section of the General Conditions. Do not include the Contractor's or Subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents. No change to the Contractor's indirect expense is permitted for selection of higher or lower priced materials or systems of the same scope and nature as originally indicated.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - PART 3 - EXECUTION****3.01 EXAMINATION**

Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to the manufacturer for replacement.

**3.02 PREPARATION**

Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related Work. Furnish templates as required to coordinate installation.

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 21 00**

## **SECTION 01 22 00**

### **UNIT PRICES**

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

##### **1.01 SUMMARY**

This Section includes administrative and procedural requirements for Unit Prices. Unit Prices are amounts stated on the Schedule of Quantities and Prices that represent full compensation for furnishing all necessary labor, materials, tools, equipment and ancillary services necessary to complete all the Work covered by each item as required in the Contract documents.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 21 00, Allowances
- B. Section 01 22 05, Lump-Sum Prices

##### **1.03 PROCEDURES**

- A. Unit prices include all necessary submittals, shop drawings, materials, labor, delivery or shipping charges, unloading or handling, insurance, installation costs, profit, all applicable taxes, and other direct and indirect expenses. Where Unit Price items require related Work specified in other sections of the Contract Specifications, but which is not specifically mentioned in the Unit Price description, the Contractor shall be responsible for and include all related work that is normally required for Work similar to the Unit Price item. Detailed descriptions and other provisions concerning Unit Price items are contained in other sections of the Plans and Specifications.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of Unit Prices. Methods of measurement and payment for Unit Prices are specified in those Sections.
- C. The Authority reserves the right to reject the Contractor's measurement of work-in-place that involves use of established Unit Prices, and to have this work measured by the Authority or an independent surveyor acceptable to the Contractor. If the Contractor's measurement is determined to be inaccurate, the Contractor shall bear the cost of this Authority quantity survey. If the Contractor's measurement is confirmed as accurate, the Authority shall bear the cost of the quantity survey.
- D. Specification Sections referenced in the Schedule of Quantities and Prices for each Unit Price describe requirements for materials, installation, and quality.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 22 00**



## **SECTION 01 22 05**

### **LUMP-SUM PRICES**

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

##### **1.01 SUMMARY**

This Section includes administrative and procedural requirements for lump sum prices which are amount(s) proposed by the Contractor and stated on the Schedule of Quantities and Prices for contracted amounts for materials, products, and operations to be provided in the envisioned scope of the Work. Lump sum prices include all necessary materials, labor, delivery or shipping charges, unloading or handling, installation costs, profit, all applicable taxes, and other direct and indirect costs.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 22 00, Unit Prices
- B. Section 01 23 00, Options

##### **1.03 PROCEDURES**

Contractor performance of Work for which Contract lump sum payments will be made shall be listed in the approved Schedule of Values. Payment for each lump sum item provides full compensation for furnishing the labor, materials, tools, and equipment, and for performing all of the Work involved to complete the Work covered by each item and included in the Contract Documents.

Where lump sum price items require related Work specified in other Sections of the Contract Specifications, but which is not specifically mentioned in the lump sum price description, the Contractor shall be responsible for and include all related Work that is normally required for work of a similar nature to the item.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 22 05**

## **SECTION 01 23 00**

### **OPTIONS**

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

##### **1.01 SUMMARY**

This Section includes administrative and procedural requirements for OPTIONS which are amount(s) proposed by the Contractor and stated on the Schedule of Quantities and Prices for specific Work defined in the bidding requirements. Options may be added to or deducted from the base bid amount if, at its sole discretion, the Authority decides to accept an option, either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 22 00, Unit Prices
- B. Section 01 22 05, Lump-Sum Prices

##### **1.03 PROCEDURES**

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the option into the Project.
- B. As part of each option, include miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of the option.
- C. Immediately following award of the Contract, notify the Authority in writing, of the status of each option. Indicate if options have been accepted, rejected, or deferred for later consideration. Notification shall include a complete description of negotiated revisions to alternates.
- D. Authority reserves the right to accept or reject any option, in any order, and to award or amend the Contract accordingly.
- E. Execute accepted options under the same conditions as other work of the Contract. The cost or credit for each option is the net addition to or deduction from the Contract Price to incorporate an option into the Work. No other adjustments to the Contract Price relating to options shall be allowed.
- F. Specification Sections referenced in the Schedule of Quantities and Prices contain requirements for materials, installation and quality necessary to achieve the Work described under each option.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 23 00**

**SECTION 01 23 50**  
**TIME-RELATED OVERHEAD**

**PART 1 – GENERAL**

**1.1 SUMMARY**

- A. This Section specifies administrative and procedural requirements relative to the payment for Time-Related Overhead associated with monthly progress payments and Contract change orders.

**1.2 RELATED SECTIONS**

- A. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 01 24 13 Value Engineering Change Proposals
  - 2. Section 01 31 99 Period of Performance

**1.3 DEFINITIONS**

- A. Time-related Overhead: Time-related overhead shall consist of those overhead and indirect costs, including field office, regional office, and home office overhead, incurred as a result of performing Work during the contractual Period of Performance, and the Authority authorized additional time added to or deducted from the Period of Performance required to complete the Work. Time-related overhead and indirect costs excludes costs that are not related to time, including but not limited to mobilization, insurance premiums, licenses, idle and active equipment, and permits. Time-related overhead shall not apply to non-compensable time extensions, Subcontractors of any tier, suppliers, fabricators, manufacturers, or other entities associated with the Contractor.
- B. Field Office Overhead: Time-related costs of field office overhead include, but are not limited to, salaries, benefits, and equipment costs of project managers, general superintendents, field office managers, and other field office staff assigned to the Project, as well as rent, utilities, maintenance, security, supplies, and equipment costs of the field office.
- C. Regional and Home Office Overhead: Regional and Home office overhead refers to the costs of operating the Contractor's business. These costs include, but are not limited to, salaries, benefits, and equipment costs of general administration, new business development, marketing, insurance, personnel and subcontract administration, purchasing, accounting, and project management and estimating.
- D. Contract Time: As defined in the Contract, the Contract Time is the original duration of the Contract in calendar days plus Change Order(s) adjustments.

**1.4 PERIOD OF PERFORMANCE**

- A. The first calendar day for the purpose of measuring time-related overhead shall be the effective date of the Notice to Proceed authorizing job-site mobilization.
- B. The last calendar day for the purpose of measuring time-related overhead shall be the Date of Substantial Completion.

### **1.5 INCREASE AND DECREASES IN TIME-RELATED OVERHEAD**

- A. One day of time-related overhead will be paid for every calendar day designated in Specification Section 01 31 99 Period of Performance. Calculation of time-related overhead costs will be based on working days with a corresponding adjustment in calendar days for Contract Time. Any adjustments must satisfy at least one of the following criteria:
  - 1. Suspensions of work ordered in conformance with the Contract except:
    - a. Suspensions of work prior to NTP.
    - b. Suspensions ordered due to the failure on the part of the Contractor to carry out orders given, or to perform the provisions of the Contract.
    - c. Suspensions ordered due to factors beyond the control of and not caused by the Authority or the Contractor, for which the Contractor is granted extensions of time in conformance with the provisions of the Specification Section 01 31 99 Period of Performance.
    - d. Other suspensions that mutually benefit the Authority and the Contractor.
  - 2. Adjustments of Contract Time granted by the Authority in conformance with the provisions and set forth in approved contract change orders.
- B. In the event an early completion progress schedule proposed by the Contractor and approved by the Authority, the quantity of time-related overhead days eligible for payment will be based on the reduced number of calendar days for the Project as approved by the Authority.

### **1.6 VECP AND TIME-RELATED OVERHEAD**

- A. The quantity of time-related overhead associated with a reduction in Contract Time for cost reduction incentive proposals accepted and executed in conformance with Section 01 24 13 Value Engineering Change Proposals (VECP) shall be considered a construction cost attributable to the resultant estimated net savings.

### **1.7 EXCESS TIME-RELATED OVERHEAD AND AUDIT**

- A. If the final quantity of time-related overhead days exceeds the original bid quantity by more than 50 percent, the Contractor shall, within 60 days of the Authority's

written request, submit to the Authority an audit examination and report performed by an independent certified public accountant of the Contractor's actual overhead costs. The audit examination and report shall depict the Contractor's project and companywide financial records and shall specify the actual overall average daily rates for both field office and home office overhead for the entire duration of the project, and whether the costs have been properly allocated. The rates of field office and home office overhead shall exclude unallowable costs as determined in the Federal Acquisition Regulations, 48 CFR, Chapter 1, Part 31.

- B. Independent audit examinations by a certified public accountant shall be performed in conformance with the requirements of the American Institute of Certified Public Accountants Attestation Standards. Audit examinations and reports shall determine if the rates of field office and home office overhead are
  - 1. Allowable in conformance with the requirements of the Federal Acquisition Regulations, 48 CFR, Chapter 1, Part 31.
  - 2. Adequately supported by reliable documentation.
  - 3. Related solely to the project under examination.
- C. The actual rate of time-related overhead specified in the audit, and submitted by the Contractor, will be subject to approval by the Authority.
- D. When requested by the Authority, the cost of performing an independent certified public accountant audit examination and submitting the report will be borne equally by the Authority and the Contractor. The cost of performing an audit examination and submitting the independent certified public accountant audit report for overhead claims other than for the purpose of verifying the actual rate of time-related overhead shall be entirely borne by the Contractor. The cost of performing an audit examination and submitting the independent certified public accountant audit report to verify actual overhead costs incurred prior to the first working day shall be entirely borne by the Contractor.

**PART 2 – PRODUCTS** (not used)

**PART 3 – EXECUTION** (not used)

**PART 4 – MEASUREMENT AND PAYMENT**

- A. For the purpose of progress payments, the number of Calendar Days to be paid for TIME-RELATED DAILY OVERHEAD RATE contract item in each monthly payment cycle will be the number of working days for that month.
- B. Provisions relating to increased or decreased Unit Price quantities shall not apply to the TIME-RELATED DAILY OVERHEAD RATE contract item.
- C. The remaining balance of TIME-RELATED DAILY OVERHEAD RATE days, as adjusted by change order, shall be paid to the contractor upon completion of all work if the contractor achieves Substantial Completion and acceptance of the Work prior to the current Contract Completion date.
- D. General Conditions GC-30.G Increased or Decreased Quantities, does not apply to the TIME-RELATED DAILY OVERHEAD RATE bid item.

**END OF SECTION 01 23 50**

## SECTION 01 24 13

### VALUE ENGINEERING CHANGE PROPOSALS (VECP)

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes administrative and procedural requirements for Value Engineering Change Proposals (VECPs) by the Contractor. The Authority encourages the Contractor to submit VECPs whenever the Contractor identifies areas or instances in which improvements can be made, in order to achieve Project cost savings.

##### 1.02 VECP REQUESTS

- A. This Section applies to the Contractor-developed and documented VECP that
  - 1. Requires a change to the Contract.
  - 2. Reduces the total Contract Price without impairing essential functions or characteristics of the Work, providing that it is not based solely on a Change in specified quantities.
  - 3. Results in an estimated total saving to the Authority equal or greater than \$2,500.
- B. At a minimum, the following information shall be submitted by the Contractor with each VECP:
  - 1. Description of the existing Contract requirements that are involved in the proposed Change.
  - 2. Description of the proposed Change, and all Specifications or Plans necessary for the complete evaluation of the proposed Change.
  - 3. Discussion of differences between existing requirements and the proposed change, together with advantages and disadvantages of each changed item.
  - 4. Itemization of the Contract requirements that must be changed if the VECP is accepted (e.g., drawing numbers and specifications).
  - 5. Justification for changes in function or characteristics of each affected item, and the effect of the Change on the performance of the end item.
  - 6. Date by which a Change Order adopting the VECP must be issued in order to obtain the maximum cost reduction, noting any effect on Contract completion time or delivery schedule.



7. Cost estimate for existing Contract requirements correlated to the Contractor's Unit Price or lump-sum breakdown and the proposed changes in those requirements, including costs of development and implementation by the Contractor.
- C. The Contractor shall submit VECPs to the Authority. The Authority will process proposals expeditiously, but shall not be liable for any delay in acting upon any proposal submitted pursuant to this Section. The Contractor may withdraw all or part of any VECP at any time prior to acceptance by the Authority, but will, at the sole discretion of the Authority, be liable for costs incurred by the Authority in reviewing the proposal. The decision of the Authority as to the rejection or acceptance of any VECP shall be at the sole discretion of the Authority.
  - D. At its sole discretion, the Authority may accept, in whole or in part and by Change Order, any VECP submitted pursuant to this Section. Designs for accepted VECPs will be accepted by the Authority for incorporation into the drawings and specifications. Until a Change Order is executed authorizing the VECP, the Contractor shall remain obligated to perform in accordance with the Contract.
  - E. If a VECP submitted by the Contractor pursuant to this Section is accepted, the Total Contract Price shall be adjusted based upon an equal sharing of the net savings by the Contractor and the Authority (50% Authority, 50% Contractor).
    1. Net savings are defined as gross savings less the Contractor's costs and less the Authority's costs.
    2. Estimated gross savings to the Contractor means the difference between the cost of performing the Work according to the existing requirement and the cost to perform the Work according to the proposed Change. In each instance, the Contractor's profit shall not be considered part of the cost
    3. The Contractor's costs means reasonable costs incurred by the Contractor in preparing the VECP and making the Change, such as cancellation or restocking charges.
    4. The Authority's costs means reasonable costs incurred by the Authority for evaluating and implementing the VECP, such as testing, redesign, and the effect on other contracts.
    5. The Contractor is not entitled to share in concurrent, collateral, or future contract savings. Collateral savings are those measurable net reductions in the Authority's costs of operation that result from the VECP, including maintenance, logistics, and Authority furnished property. Concurrent contract savings cover the reductions in the cost of performance of other contracts the Contractor is participating in, for essentially the same item resulting from a VECP submitted by the Contractor.
    6. The Contractor's profit shall not be reduced by application of the VECP.
  - F. The Contractor shall include appropriate VECP provisions in all Subcontracts of \$25,000 or greater, and may include those provisions in any subcontract.

- G. Within the limits stated in the Contract, the Contractor may restrict the Authority's right to use any part of a VECP or the supporting data thereof in accordance with the terms of the following:
1. Data supplied pursuant to the Section entitled VALUE ENGINEERING CHANGE PROPOSALS (VECP) in this Contract shall not be disclosed to any outside person or agency, or duplicated, used, or disclosed, in whole or in part, for any purpose other than to evaluate a VECP submitted under said Section.
  2. This restriction does not limit the Authority's right to use information contained in this VECP if it is or has been obtained, or is otherwise available, from the Contractor or from another source without limitations.
  3. If a VECP is accepted by the Authority after the use of the data in an evaluation, the Authority may duplicate, use, or disclose any data reasonably necessary to the full utilization of the VECP, as accepted, in any manner and for any purpose whatsoever; the Authority may allow others to do so as well.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 24 13**

## **SECTION 01 25 00**

### **SUBSTITUTION PROCEDURES**

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

##### **1.01 SUMMARY**

This Section includes administrative and procedural requirements for substitutions which are the Contractor proposed changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 23 00, Options
- B. Section 01 33 00, Submittal Procedures
- C. Section 01 40 00. Quality requirements
- D. Section 01 60 00, Product Requirements

##### **1.03 SUBSTITUTION FOR SPECIFIED PRODUCTS**

The Contract Documents, including Contract Drawings, and Specifications have been prepared to complement and accommodate certain specified equipment, products or systems, and any modifications, adjustments, or redesign required to assimilate any Authority approved substitution of "or equal" equipment, products, or systems shall be at the Contractor's sole expense. The Contractor shall provide a complete and workable application and shall satisfy design criteria and aesthetic values to the sole satisfaction of the Authority. The Contract Time for completion of the Work specified in the Contract Documents shall not be affected by any circumstances whatsoever arising from the provisions of this Specification.

##### **1.04 EQUALS**

Except as may be provided in the Special Conditions, or stated otherwise in the various sections of the Specifications, whenever any material, product, thing, or service is specified or indicated in the Contract Documents by brand, trade, patent, or proprietary name or by the name of the manufacturer, the item so specified or indicated shall be deemed to be followed by the words "or equal."

During the Contract Bid Period, the Contractor may at its own risk, submit an item not specified in the Contract Documents as an "or equal" for consideration by the Authority. Failure to do so within the time frame described in the Instructions to Bidders shall bar the Contractor from proposing or substituting an "or equal" item for an item specified in the Contract Documents.

If the Contractor submits an “or equal” item, the Contractor must submit sufficient data to the Authority to substantiate the specific characteristics and qualities that make the “or equal” item the equivalent, as described in the paragraph below. The Contractor shall furnish such substantiating data or arrange for any necessary tests to verify the equivalent qualities of the “or equal” item at the Contractor’s sole expense.

The Authority, in its sole discretion, shall determine whether the substantiating data demonstrates that an “or equal” item is equivalent in all respects to the item specified in the Contract Documents. If the Authority determines that the “or equal” item has not been substantiated to be equivalent in all respects, the item specified in the Contract Documents shall be furnished and installed by the Contractor, without modification of the cost proposal amount or Contract Documents.

### **1.05 SUBSTITUTION REQUESTS**

- A. The Contractor shall submit request for consideration identifying product or fabrication or installation method to be replaced. Include Specification Section number, sub-section if applicable, and title and Contract Drawing numbers and titles. Indicate type of substitution:
1. Substitutions for Cause: Changes proposed by the Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  2. Substitutions Required Because of Federal Government Restrictions: Changes proposed by the Contractor that result from Federal Government restrictions or other causes growing out of the national defense or war programs.
  3. Substitutions for Lack of Availability: Changes proposed by the Contractor because certain materials or equipment specified are entirely unobtainable or not obtainable in sufficient quantities or within a reasonable time.
  4. Substitutions for Convenience: Changes proposed by the Contractor or the Authority that are not required in order to meet other Project requirements but may offer advantage to the Contractor or the Authority.
- B. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
1. A statement indicating why the specified product or fabrication or installation cannot be provided, if applicable.
  2. Coordination information including a list of changes or revisions needed to other parts of the Work and to construction performed by the Authority and separate Contractors—that will be necessary to accommodate the proposed substitution.

3. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Include an annotated copy of the applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
  4. Product data, including drawings and descriptions of products and fabrication and installation procedures.
  5. Samples, where applicable or requested.
  6. Certificates and qualification data, where applicable or requested.
  7. A list of similar installations for completed projects, with project names and addresses and the names and addresses of pertinent Engineers and Authorities.
  8. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
  9. Research reports demonstrating compliance with building codes in effect for the Project, from recognized testing laboratories or agencies, technical trade associations, and code authorities.
  10. A detailed comparison of the Contractor's construction schedule using the proposed substitution with products specified for the Work, including the effect on the overall Contract Time. If the specified product or method of construction cannot be provided within the Contract Time, include a letter from the manufacturer, on the manufacturer's letterhead, stating the date of receipt of the purchase order and attesting to the lack of availability or delays in delivery.
  11. Cost information, including a proposal of change (if any) in the Contract Price.
  12. The Contractor's certification that the proposed substitution complies with requirements in the Contract Documents, except as indicated in the substitution request; is compatible with related materials; and is appropriate for the indicated applications.
  13. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of any failure of the proposed substitution to produce indicated results.
- C. Authority's Action: If necessary, the Authority will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. The Authority will notify the Contractor of acceptance or rejection of a proposed substitution within 14 days of receipt of request, or within seven days of receipt of additional information or documentation (whichever is later).

1. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
2. Use the product specified if the Authority does not issue a decision on use of a proposed substitution within the time allocated.

## **PART 2 - PRODUCTS**

### **2.01 SUBSTITUTIONS**

- A. Substitutions for Cause, Federal Government Restrictions or due to Lack of Availability: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to the time required for preparation and review of related submittals.

The Authority will consider the Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, the Authority will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution is consistent with the Contract Documents and will produce the indicated results.
2. Requested substitution provides sustainable design characteristics that specified product provided.
3. Substitution request is fully documented and properly submitted.
4. Requested substitution will not adversely affect the Contractor's construction schedule.
5. Requested substitution has received necessary approvals of authorities having jurisdiction.
6. Requested substitution is compatible with other portions of the Work.
7. Requested substitution has been coordinated with other portions of the Work.
8. Requested substitution provides the specified warranty.
9. If the requested substitution involves more than one Contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all Contractors involved.

- B. Substitutions for Convenience: The Authority will consider requests for substitution if received within 45 days after the Notice of Award. Requests received after that time may be considered or rejected at the discretion of the Authority. The Authority will consider the Contractor's request for substitution when the conditions below are satisfied. If the following conditions are not satisfied, Authority will return requests without action, except to record noncompliance with these requirements:
1. Requested substitution offers Authority a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Authority must assume. The Authority's additional responsibilities may include compensation to the Authority for redesign and evaluation services, increased cost of other construction by the Authority, and similar considerations.
  2. Requested substitution does not require extensive revisions to the Contract Documents.
  3. Requested substitution is consistent with the Contract Documents and will produce the indicated results.
  4. Requested substitution provides sustainable design characteristics that the specified product provided.
  5. Substitution request is fully documented and properly submitted.
  6. Requested substitution will not adversely affect the Contractor's construction schedule.
  7. Requested substitution has received necessary approvals of authorities having jurisdiction.
  8. Requested substitution is compatible with other portions of the Work.
  9. Requested substitution has been coordinated with other portions of the Work.
  10. Requested substitution provides the specified warranty.
  11. If requested substitution involves more than one Contractor, the requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all Contractors involved.

### **PART 3 - EXECUTION (NOT USED)**

### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 25 00**

## **SECTION 01 26 14**

### **REQUEST FOR INFORMATION**

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

##### **1.01 SUMMARY**

This Section covers the general requirements for the Contractor's Requests for Information and pertains to all portions of the Contract Documents.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 11 13, Work Covered by the Contract Documents
- B. Section 01 33 00, Submittal Procedures

##### **1.03 REQUESTS FOR INFORMATION**

- A. The Contractor shall examine all Contract Documents; shall verify all figures in the Contract Documents before laying out the Work; shall promptly notify the Authority of all errors, discrepancies, inconsistencies, or omissions that it discovers; and, in instances where such nonconformities are discovered, shall obtain specific instructions in writing from the Authority by utilizing the RFI process before proceeding with the Work.
- B. When the Contractor is unable to determine from the Contract Documents the exact material, process, or system to be installed, the Contractor shall ask the Authority to clarify the indeterminate item. Wherever possible, such clarification shall be requested at the next appropriate project meeting, with the response entered into the meeting minutes. When clarification at the meeting is not possible, either because of the urgency of the need or the complexity of the item, the Contractor shall prepare and submit a written RFI to the Authority in the form and format established by the Authority.
- C. The Contractor's performance of work affected by such nonconformities prior to the Authority's response shall be at the Contractor's risk; however, the Contractor shall continue to perform any incidental work not affected by the nonconformity
- D. In the event of any doubt or question concerning the true meaning of the Contract Documents, or should it appear that the Work to be done or any of the matters relative thereto are not sufficiently detailed or explained in the Contract Documents, the Contractor shall submit a RFI to the Authority for such further written explanations as may be reasonably necessary, and shall conform to the written explanation given as if it were part of the Contract Documents. The decision of the Authority in such cases shall be final.



- E. RFIs shall be submitted on the latest SCRRA RFI form provided by the Authority. Forms shall be completely filled in, and, if prepared by hand, shall be fully legible after photocopying. Each page of attachments to RFIs shall bear the RFI number in the lower right-hand corner. Each RFI shall reference a drawing number or a Specification Section. RFIs from Subcontractors or Material suppliers shall be submitted through, reviewed by, and signed by the Contractor prior to submittal to the Authority.
- F. The Contractor shall submit RFIs in a timely manner to avoid delays to the progress of the Work. RFIs prepared and submitted by the Contractor shall be complete and shall include all information or references necessary for The Authority to respond.
- G. The Authority will respond to RFIs in a timely manner. The target response time for RFIs will be 10 working days but will be no longer than 20 working days. In the event that there are numerous RFIs pending, the Contractor shall cooperate with the Authority in establishing a priority for responding to the RFIs.
- H. In the event that an RFI is reviewed by a third-party (including Railroad Operator<sup>4</sup>s and authorities having jurisdiction), allow up to an additional 10 working days for the Authority's response.
- I. Authority's response to RFI may include a request for additional information in which case Authority's time for response will date from time of receipt of additional information.
- J. The Contractor shall not assert any claims for delay or interference against the Authority if the Contractor fails to submit any RFI in a timely manner to the Authority (taking into account the time allowed for a response period allowed for the Authority).
- K. The response to an RFI shall not, by itself, constitute authorization for the Contractor to perform any Change Work that causes an adjustment to either the Period of Performance or the Contract Amount.
- L. RFIs shall not be used for the following purposes:
  - 1. To request approval of submittals
  - 2. To request approval of substitutions
  - 3. To request changes that entail additional cost or credit
  - 4. To request different methods of performing work other than those drawn or specified
  - 5. Such RFIs shall be discarded and not counted or recorded.

- M. In the event the Contractor believes that a clarification by the Authority results in additional cost, the Contractor shall not proceed with the Work indicated by the RFI until a Change Order is prepared and approved. Neither answered nor unanswered RFIs shall be construed as approval to perform extra work or entitlement to adjust Period of Performance or the Contract Amount.
- N. Unanswered RFIs will be returned with a stamp or notation indicating "Not Reviewed," and not counted or recorded.
- O. The Contractor shall prepare and maintain a log of RFIs and, at any time so requested by the Authority, the Contractor shall furnish copies of the log showing all outstanding RFIs. The Contractor shall note all unanswered RFIs in the log.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 26 14**

**SECTION 01 29 73**  
**SCHEDULE OF VALUES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This Section specifies administrative and procedural requirements necessary to prepare and process the Schedule of Values

**1.02 RELATED REQUIREMENTS**

- A. Section 01 22 00, Unit Prices
- B. Section 01 22 05, Lump-Sum Prices
- C. Section 01 23 00, Options

**1.03 DEFINITIONS**

Schedule of Values: A tabulation furnished by the Contractor and approved by the Authority, allocating portions of the Contract Price to various portions of the Work which shall be used as the basis for reviewing the Contractor's applications for payment.

**1.04 SCHEDULE OF VALUES DEVELOPMENT**

- A. Coordinate preparation of the Schedule of Values with preparation of the Contractor's construction schedule.
- B. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
  - 1. Application for Payment forms with continuation sheets
  - 2. Submittal schedule
  - 3. Items required to be indicated as separate activities in the Contractor's construction schedule
- C. Where the Work is separated into phases requiring separately phased payments, provide values correlated with each phase of payment. Where the Contractor's construction schedule defines separate elements of the Work, provide values correlated with each element.
- D. Format and Content: Use the Specification sections as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification section.

- E. Identification: Include the following Project identification on the Schedule of Values:
1. Project name and location
  2. Authority's project number
  3. The Contractor's name and address
  4. Segment and Phase of project
  5. Date of submittal
- F. Arrange the Schedule of Values in a manner consistent with the format of CSI Master Format 2004.
- G. Arrange the Schedule of Values in tabular form, with separate columns to indicate the following for each item listed:
1. Related Specification Section or Division
  2. Description of the Work
  3. Name of Sub-Contractor
  4. Name of manufacturer or fabricator
  5. Name of supplier
  6. Change Orders (numbers) that affect value
- H. Provide a breakdown of the Contract Price in enough detail to facilitate continued evaluation of applications for payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of one half of one percent of the Contract Price.
- I. Include separate line items under the Contractor and principal subcontracts for project closeout requirements in an amount totaling one half of one percent of the Contract Price and five percent of the subcontract amount.
- J. Each item of the Schedule of Values shall include its proportionate share of profit, and all other expenses involved.
1. The summation of extensions of quantities and unit prices and related costs shall equal the amount of the lump-sum price of the applicable Contract bid item indicated in the Schedule of Quantities and Prices.
  2. Round amounts to the nearest whole dollar; the total shall equal the Contract Price.

3. Provide a separate line item in the Schedule of Values for mobilization and demobilization for each time and part and phase of the work where the Contractor is required to mobilize and demobilize its operations.
  4. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
  5. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
  6. Provide separate line items in the Schedule of Values for the preparation of submittals, initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
  7. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
  8. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show the line item value of each purchase contract. Indicate Authority payments or deposits, if any, and the balance to be paid by the Contractor.
  9. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general profit for each item.
  10. Mobilization and Demobilization and other major cost items that are not direct cost of actual work in place may be shown either as separate line items in the Schedule of Values or distributed within the costs allocated to the values of Time-Related Overhead, at the Contractor's option.
- K. The Contractor shall be responsible for the accuracy of the quantities and values used in the Schedule of Values. No adjustment in compensation will be made due to differences between the quantities shown in the Schedule of Values furnished by the Contractor and the quantities required to complete the Work as shown on the Contract Drawings and as specified in these Contract Documents.
- L. The Authority will not approve the Schedule of Values if the amounts are unreasonable and unbalanced. The Contractor shall provide any supporting documentation necessary for the Authority to determine acceptability.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 PREPARATION**

At the Preconstruction Meeting or within 7 days after the effective date of the Notice to Proceed, the Contractor shall submit to the Authority a detailed Schedule of Values that must be approved by the Authority prior to the Contractor's first application for progress payment.

**3.02 APPROVAL**

Upon approval by the Authority, the Schedule of Values will form a basis for determining the compensation payable to the Contractor based on actual progress of Work, in accordance with the approved progress schedule, with respect to each Contract bid item to be paid by lump sum. No progress payment for Contract bid items to be paid by lump sum shall be made without an approved Schedule of Values.

**3.03 REVIEW AND RESUBMITTAL**

If review by the Authority indicates that changes to the Schedule of Values are required, the Contractor shall revise and resubmit in the same manner as the original Schedule of Values was approved.

**3.04 SCHEDULE UPDATING**

Update and resubmit the Schedule of Values before each application for payment when Change Orders or Work Authorization Change Notices result in a change in the Contract Price.

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 29 73**

## **SECTION 01 31 00**

### **PROJECT MANAGEMENT AND COORDINATION**

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

##### **1.01 SUMMARY**

This section contains administrative provisions for coordinating construction operations and general project coordination procedures under this Contract.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 11 16, Work by SCRRA
- B. Section 01 14 16, Coordination with SCRRA
- C. Section 01 43 23, Contractor Qualifications and Requirements

##### **1.03 COORDINATION**

- A. Coordinate construction operations and Work included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation. Schedule construction operations in the sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components (before or after its own installation). Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair. Make adequate provisions to accommodate items scheduled for later installation.
- B. Each Contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings. Prepare similar memoranda for the Authority and for separate Contractors if coordination of their Work is required.
- D. Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include but are not limited to the following:
  - 1. Preparation of Contractor's construction schedule.
  - 2. Preparation of Contractor's Schedule of Values.
  - 3. Installation and removal of temporary facilities and controls.

4. Delivery and processing of submittals.
  5. Progress meetings.
  6. Pre-installation conference.
  7. Project closeout activities.
  8. Startup and adjustment of systems (commissioning).
- E. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other sections of these Specifications for disposition of salvage materials that are designated to be owner's property.

#### **1.04 PROJECT MEETINGS**

- A. General: CM or Contractor will schedule and conduct weekly meetings and conferences at the Project site, unless otherwise indicated.
- B. Preconstruction Conference: The Authority will schedule and conduct a preconstruction conference before starting construction, at a time convenient to the Authority, but no later than 15 days after execution of the Agreement.
1. Conference will review responsibilities and personnel assignments.
  2. Attendees: Authorized representatives of Authority and their consultants; the Contractor and its superintendent; major Subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  3. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Tentative construction schedule, Critical work sequencing and long-lead items
    - b. Emergency Procedures and Contact Information
    - c. Phasing
    - d. Site access and the Contractor's ON-SITE laydown, storage, and staging area
    - e. Designation of key personnel and their duties
    - f. Lines of communications



- g. Procedures for processing field directives and Change Orders
  - h. Procedures for RFIs
  - i. Procedures for testing and inspecting
  - j. Procedures for processing Applications for Payment
  - k. Distribution of the Contract Documents
  - l. Submittal procedures
  - m. Sustainable design requirements
  - n. Preparation of record documents
  - o. Use of the premises [and existing buildings]
  - p. Work restrictions
  - q. Working hours
  - r. Worksite safety and first aid requirements
  - s. Authority's occupancy requirements
  - t. Responsibility for Mobilization and Demobilization and controls
  - u. Procedures for moisture and mold control
  - v. Procedures for disruptions and shutdowns
  - w. Construction waste management and recycling
  - x. Parking availability
  - y. Office, work, and storage areas
  - z. Equipment deliveries and priorities
  - aa. Security
  - bb. Progress cleaning
- C. Pre-installation Conferences: Conduct a pre-installation conference at the Project site before each construction activity that requires coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Authority of scheduled meeting dates.

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
  - a. Contract Documents
  - b. Options
  - c. Related RFIs
  - d. Related Change Orders
  - e. Purchases
  - f. Deliveries
  - g. Submittals
  - h. Review of mockups
  - i. Possible conflicts
  - j. Compatibility requirements
  - k. Time schedules
  - l. Weather limitations
  - m. Manufacturer's written recommendations
  - n. Warranty requirements
  - o. Compatibility of materials
  - p. Acceptability of substrates
  - q. Mobilization and Demobilization and controls
  - r. Space and access limitations
  - s. Regulations of authorities having jurisdiction
  - t. Testing and inspecting requirements
  - u. Installation procedures
  - v. Coordination with other work
  - w. Required performance results
  - x. Protection of adjacent work

- y. Protection of construction and personnel
  - z. Safety requirements
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
  4. Reporting: Distribute minutes of the meeting to each party present, the Authority, and to other parties requiring information.
  5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Authority will schedule and conduct a Project closeout conference, at a time convenient to all attendees, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
  2. Attendees: Authorized representatives of the Authority, the Engineer, Authority Commissioning personnel, and their consultants; the Contractor and its project manager; major Subcontractors; Suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
  3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
    - a. Preparation of record documents
    - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance
    - c. Submittal of written warranties
    - d. Requirements for preparing operations and maintenance data
    - e. Requirements for demonstration and training
    - f. Preparation of the Contractor's punch list
    - g. Procedures for processing Applications for Payment at Substantial Completion and for final payment
    - h. Submittal procedures
    - i. Coordination of separate contracts

- j. Authority's partial occupancy requirements
  - k. Installation of Authority's furniture, fixtures, and equipment
  - l. Responsibility for removing Mobilization and Demobilization and controls
4. Minutes: Record and distribute meeting minutes to Authority and all attendees.
- E. Progress Meetings: Authority will conduct progress meetings at weekly intervals.
- 1. Coordinate dates of meetings with preparation of payment requests.
  - 2. Attendees: In addition to representatives of Authority, each Contractor, Subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
  - 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.
    - a. The Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule in relation to the Contractor's construction schedule. Determine how construction that has fallen behind schedule will be remedied; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
    - b. Review the schedule for the next period.
    - c. Review present and future needs of each entity present, including the following:
      - 1) Interface requirements
      - 2) Sequence of operations
      - 3) Status of submittals
      - 4) Deliveries
      - 5) Off-site fabrication
      - 6) Access
      - 7) Site utilization

- 8) Mobilization and Demobilization and controls
- 9) Progress cleaning
- 10) Quality and work standards
- 11) Status of correction of deficient items
- 12) Field observations
- 13) Status of RFIs
- 14) Status of proposal requests
- 15) Pending changes
- 16) Status of Change Orders
- 17) Pending claims and disputes
- 18) Documentation of information for payment requests

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 31 00**

## **SECTION 01 31 19**

### **PARTNERING**

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

##### **1.01 SUMMARY**

The Authority will promote the formation of a “Partnering” relationship with the Contractor to effectively complete the Contract to the benefit of both parties. This partnering relationship will be structured to draw on strengths of each organization to identify and achieve mutual goals. The purpose of this relationship will be to maintain cooperative communication and mutually resolve conflicts in accordance with the terms of the Contract.

##### **1.02 RELATED REQUIREMENTS**

A. Section 01 21 00, Allowances

##### **1.03 PARTNERING FACILITATION**

To implement this partnering initiative, prior to starting field Work, the Contractor's management personnel and the Authority will initiate a partnering development Team-building workshop. Project personnel shall work with the assistance of a Facilitator to make arrangements and to determine attendance, agenda, duration, and location of the workshop. Persons required to be in attendance will be the Authority's management staff and key project personnel representing the Authority, the Contractor's management staff and key project supervision personnel of both the Contractor and principal Subcontractors and suppliers, and representatives of respective utility companies. The project design engineers and other key personnel will also be invited to attend, as necessary.

If mutually agreed, follow-up workshops may be held periodically throughout the duration of the Contract.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

The Contractor shall be responsible for making all the necessary arrangements to provide a Facilitator, associated materials and a workshop site. Such arrangements shall be mutually agreed upon in advance by the Contractor and the Authority.

#### **PART 4 - MEASUREMENT AND PAYMENT**

The Authority shall approve all direct costs, and each party will be assessed for 50% of such costs. The reimbursable portion of the Contractor's costs associated with Partnering will be made by modification to the contract and payment will be made under the allowance item for Partnering in the Schedule of Quantities and Prices.

**END OF SECTION 01 31 19**

## SECTION 01 31 99

### PERIOD OF PERFORMANCE (2 STEP NTP)

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes administrative and procedural requirements for a two-step Notice-to-Proceed process, and defines allowable conditions for Contract Time extensions.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 29 73, Schedule of Values
- B. Section 01 33 00, Submittal Procedures
- C. Special Conditions Section – Commencement of the Work

##### 1.03 DEFINITIONS

- A. Limited Notice to Proceed: SCRRA written authorization to commence the performance of specified activities within the Work.
- B. Notice to Proceed: SCRRA written authorization to proceed with all or portions of the Work, as specified.
- C. Contract Time: As stated in the Contract, the original duration of the Contract in calendar days plus Change Order adjustments

##### 1.04 COMMENCEMENT OF WORK

The Authority will employ a two-step Notice to Proceed. As specified in the Contract Special Conditions, the Authority will issue a "Limited Notice to Proceed," no later than 20 days after, or as early as one day after, execution of the Contract. The Contractor is not authorized to perform any work until the Contractor has received the Limited Notice to Proceed from the Authority. Should the Contractor begin Work in advance of receiving the Limited Notice to Proceed, such Work shall be considered as having been done at the Contractor's own risk. The Limited Notice to Proceed will initiate the Contract Time and will constitute a notice to proceed with specified Work tasks and deliverables.

The full "Notice to Proceed" will not be issued prior to the Authority's acceptance of completion of all activities initiated by the "Limited Notice to Proceed," above. The issuance of the full "Notice to Proceed" will be a notice for the Contractor to proceed with all remaining Work and diligently prosecute the same to completion within the Contract Time.

##### 1.05 PERIOD OF PERFORMANCE

The date of the Limited Notice to Proceed is the start date for the Contract Period of Performance.

**1.06 DELAYS AND TIME EXTENSIONS**

- A. Delays beyond the Contractor's control: The Contractor will be granted an extension of time and will not be assessed with liquidated damages for any delay in substantially completing the Work (or parts thereof) beyond the time set forth in the Contract, provided that such delay was caused by unforeseeable causes beyond the control and without the fault or negligence of the Contractor. Examples of such causes include acts of a public enemy, fire, floods, adverse weather, tidal waves, earthquakes, hurricanes, epidemics, quarantine restrictions, strikes, labor disputes and freight embargoes, or negligent acts of the Authority.
- B. Authority caused delays: In the event the Contractor is actually and necessarily delayed by any act or omission on the part of the Authority (as determined by the Authority), and provided that the Contractor notifies the Authority in writing within 5 days from the beginning of any such delay, specifying the act or omission causing such delay, the time for completion of the Work may be extended at the sole discretion of the Authority. In all cases, any extension of time is contingent on all of the following:
1. That the cause is not due to the fault or negligence of the Contractor, and the Contractor has taken reasonable precautions to prevent the delays and minimize the effects thereof.
  2. That the Contractor submits a Request for Change (RFC) specifying the nature of the delay and the measures that have been or will be taken to prevent or minimize the delay. Failure to submit written notice within this time period shall constitute an absolute waiver of any claim for a time extension. The RFC submitted by the Contractor shall also include a Time Impact Analysis as required in the Specification.
  3. No extension of time will be granted under this Section for any Authority caused delay in which (1) the performance of Work would have been concurrently delayed by the Contractor induced causes, including an act or omission of the Contractor or its Subcontractors, or (2) remedies are included or excluded by any other provision of the Contract. Only the actual delay necessarily resulting from the causes specified in this Section shall be grounds for an extension of time. In case the Contractor is delayed at any time or for any period by two or more of the causes specified in this Section, the Contractor shall not be entitled to a separate extension for each one of the causes; only one extension will be granted for the entire delay.
  4. No extension of time will be granted for a delay caused by a shortage of materials unless the Contractor furnishes to the Authority (a) documentary proof that the Contractor has diligently made every effort to obtain such materials from all known sources within reasonable reach of the work site(s), and (b) further proof, in the form of schedule data as required under Section 01 32 17, Construction Project Schedule, that the inability to obtain such materials when originally planned did in fact cause a delay in Substantial Completion of a portion of the Work or the entire Work, one that could not be compensated for by revising the sequence of the Contractor's operations.



5. The term “shortage of materials,” as used in this Section, shall apply only to materials, articles, parts, or equipment that are not custom items; it and shall not apply to equipment, materials, parts, or articles that are processed, made, constructed, fabricated, or manufactured to meet the specific requirements of the Contract Documents. Only conditions not in the control of the Contractor that result in the physical shortage of materials will be considered as a cause for extension of time, and no consideration will be given to any claim that material could not be obtained at a reasonable, practical, or economical cost or price, unless it is shown to the satisfaction of the Engineer that such material could have been obtained only at exorbitant prices entirely out of line with current rates, taking into account the quantities involved and the usual practices in obtaining such quantities.
- C. When inclement weather at the Project site affects Critical Path activities, the Contractor may provide the Authority with a written request for a weather impact day that fully describes the inclement weather delay on the Critical Path activities. Excusable, non-compensable Contract time extensions for weather delays will only be considered for such delays that affect activities on the critical path of the Contract, as defined by the schedule current at the time of the delay. Such time extensions, if approved, will be non-compensable and shall be requested by the Contractor in accordance with Contract Change Order procedures subject to the following:
1. A weather delay day is defined as a day on which the Contractor is prevented by inclement weather or conditions resulting immediately therefrom, as determined by the Authority from proceeding with at least 75 percent of the normal labor and equipment force engaged on Critical Path activities for at least 60 percent of the total daily time being currently spent on the Critical Path activities. Weather delays may consist of days lost to inclement weather conditions, days lost to dry out of exposed soil, or days lost to site clean-up due to inclement weather but only after the weather impact area affecting the Critical Path activities has exhausted the allotted cumulative Rain Day Impact Allowance.
  2. The table below lists the typical number of inclement weather days per month. Only days lost due to weather in a given month in excess of the number listed for that month will be considered for a time extension. Weather delay days are not cumulative from month to month.

Typical Number of Days of Inclement Weather			
<b>Month</b>	<b><u>No. of Days</u></b>	<b>Month</b>	<b><u>No. of Days</u></b>
January	5	July	0
February	5	August	0
March	5	September	0
April	4	October	0
May	3	November	3
June	0	December	5

3. Weather impact days will not be granted for inclement weather that occurs on non-scheduled workdays. If the effects of inclement weather from a non-scheduled work day carry forward to a scheduled work day and affects the Critical Path as noted above, then the scheduled work day will be considered affected by weather.
  4. If the Contractor asks to work a specific weekend or holiday and gives the Authority advance written notification of critical-path work to be performed, and if a substantial amount of precipitation occurs that prevents the work from being performed, that day can be claimed as a weather impact day. Any unused rain day allowance at the end of the project will be shown as available float to the Substantial Completion milestone.
- D. Time Extensions for Critical Path activities only: No extensions of time will be granted for delays that have no measurable impact on the completion of the Work (or parts thereof) under the Contract Documents. When extensions of time are granted, they shall be limited to the period equivalent to the actual number of days lost on the Critical Path or controlling operations of the Project Baseline Schedule or other applicable construction schedule, taking into account the extent to which that delay could be decreased by reasonable mitigation measures by the Contractor. All requests for extensions of time shall be supported with a critical path analysis showing the critical path and impacts on it. The Contractor's failure to submit this analysis will be sufficient cause for denial of any request for a time extension.
- E. An extension of time granted shall not release the Contractor's Surety from its obligations. Work shall continue and be carried on in accordance with all provisions of the Contract. The Contract shall remain in full force and effect during the continuance and until completion and acceptance of the Work covered by the Contract, unless formally suspended or terminated in accordance with the terms of the Contract. Permitting the Contractor to finish the Work, or any part thereof, after the time fixed for completion (or after the date to which the time for completion may have been extended), and/or making payments to the Contractor after any such periods, shall not constitute a waiver on the part of the Authority of any rights under the Contract.

- F. Neither the granting of an extension of time beyond the date fixed for the completion of any part of the Work nor the performance and acceptance of any part of the Work after the time specified for the completion of the Work shall be deemed to be a waiver by the Authority of the Authority's right to terminate the Contract for abandonment or failure to complete within the time specified, or to impose and deduct damages as may be specified.
- G. In all cases in which the Contractor either Claims or intends to Claim a delay, the Contractor shall comply with those provisions contained in the Contract.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 31 99**

## SECTION 01 32 17

### CONSTRUCTION PROJECT SCHEDULE

#### PART 1 - GENERAL

##### 1.01 SUMMARY

Section includes requirements for preparing, submitting, revising, and updating project scheduling information. The purpose of this section is to ensure adequate planning and execution of the Work by the Contractor and to establish a standard against which satisfactory completion of the Project can be measured by the Authority and provide justification for progress payments.

##### 1.02 GENERAL

- A. The scheduling and execution of the Work in accordance with the Contract Documents are the responsibility of the Contractor. Schedules shall represent a practical plan to complete the Work within the Contract Time and shall convey the Contractor's intent in the manner of prosecution and progress of the Work. The submittal of schedules shall be understood to be the Contractor's representation that the schedule meets the requirements of the Contract Documents and that the Work will be executed in the sequence and duration indicated in the schedule.
- B. Schedules shall be consistent with the time and work requirements of the Contract. The Contractor shall execute the Work in the sequence indicated on the current approved schedule.
- C. The Contractor shall involve and coordinate with all Subcontractors, third parties, and material suppliers in the development and updating of schedules.
- D. Review or acceptance of schedules by Authority shall not waive any contract requirements and shall not relieve the Contractor of any obligation or responsibility for submitting complete and accurate information.
- E. If after a schedule has been accepted or approved by the Authority, either the Contractor or the Authority discovers that any aspect of the schedule has an error or omission, the Contractor shall correct it on the next Progress Schedule.
- F. Errors or omissions on schedules shall not relieve the Contractor from finishing all work within the Contract Time.
- G. The Contractor shall adjust, add to, or clarify any portion of a schedule which the Authority determines to be insufficient for monitoring the Work or to be impractical for any reason.
- H. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints and extended activity durations will be cause for rejection of schedule submittal.

### 1.03 RELATED SECTIONS

- A. Section 01 29 73, Schedule of Values
- B. Section 01 31 99, Period of Performance

### 1.04 DEFINITIONS

- A. Activity: A task, event or other project element on a schedule that contributes to completing the project. Activities have a description, start date, finish date, duration and one or more logic ties.
- B. Actual Dates: The actual start or finish date of an activity which occurs prior to the data date. Dates occurring after the data date are forecasted dates and are not actual dates.
- C. Bar Chart (Gantt Chart): A graphic display of schedule-related information in which activities or other project elements are listed down the left side of the chart, dates are shown across the top, and activity durations are shown as date-placed horizontal bars.
- D. Baseline Schedule: The initial schedule representing the Contractor's work plan on the first working day of the project as approved by the Authority.
- E. Contract Completion Date: Contracted original completion date defined by the duration of the project.
- F. Controlling Operation: The activity, within that series of activities defined as the applicable critical path, which if delayed or prolonged will delay the scheduled completion date of the Work.
- G. Critical Path: The longest continuous chain of activities for the project that has the least amount of total float of all chains. In general, a delay on the critical path will extend the scheduled completion date.
- H. Critical Path Method (CPM): A network-based planning technique using activity durations and the relationships between activities to mathematically calculate a schedule for the entire project.
- I. Data Date: The day after the date through which a schedule is current. Everything occurring earlier than the data date is "as-built" and everything on or after the data date is "planned."
- J. Day: Refers to working days, which are any days other than any days declared holidays by the Authority.
- K. Early Completion Date: A scheduled completion date which is earlier than the contract completion date.
- L. Free Float: The amount of time an activity can be delayed before affecting a subsequent activity.

- M. Hammock Activity: An activity added to the network to span an existing group of activities for summarizing purposes.
- N. Milestone: A marker in a network which is typically used to mark a point in time or denote the beginning or end of a sequence of activities. A milestone has zero duration but will otherwise function in the network as if it were an activity.
- O. Narrative Report: A document submitted with each schedule that discusses topics related to project progress and scheduling.
- P. Near Critical Path: A chain of activities with total float exceeding that of the critical path but having no more than 10 working days of total float.
- Q. Open Ended Activity: An activity without at least one predecessor and one successor.
- R. Out of Sequence Activities: Any activity which actually starts in a sequence other than shown in the current approved schedule.
- S. Progress Schedule: A current schedule developed from the baseline or subsequent schedule through regular monthly review to incorporate as-built progress and any planned changes.
- T. Revision: A change in the schedule that modifies logic, adds or deletes activities, or alters activities, sequences, or durations.
- U. Scheduled Completion Date: The planned date of completion of the Work shown on the current approved schedule.
- V. Time Impact Analysis: A schedule and narrative report developed specifically to demonstrate what effect a proposed change or delay has on the current scheduled completion date.
- W. Total Float: The amount of time that an activity or chain of activities can be delayed before extending the scheduled completion date.

### **1.05 SUBMITTALS**

- A. Baseline Schedule: Submit Baseline Schedule to the Authority within 28 calendar days following the date of the Limited Notice to Proceed for review and approval or within 15 working days from the Notice to proceed when a separate LNTP is not issued.
- B. 90-Day Preliminary Schedule: Submit 90-Day Preliminary Schedule to the Authority within 14 calendar days following date of the Limited Notice to Proceed for review and approval.
- C. Progress Schedule: Progress Schedule is due as part of the submittal of progress payment application for review and approval. The data date shall be set one day after the period in that month's progress payment application period.

- D. Final Progress Schedule shall be submitted within 14 calendar days following Substantial Completion for review and approval.
- E. Subcontractor Documentation:
  - 1. Submit with the Baseline Schedule all Subcontractor schedules utilized in the development of the Baseline Schedule.
  - 2. Submit with the Baseline Schedule, a statement on Subcontractor's letterhead, certifying that Subcontractor has reviewed and concurs with the Baseline Schedule and that Subcontractor's related schedule has been reasonably incorporated, including activity duration
- F. Scheduler Qualifications: At Pre-Construction meeting, submit for the Authority's acceptance a resume of the individual proposed to perform scheduling. If the accepted individual leaves the Project or is assigned duties which no longer permit the individual to perform scheduling, notify the Authority and submit for acceptance the resume of the proposed replacement. Proposed individual must have a minimum of 5 years of verifiable scheduling experience.
- G. Submit for Authority's use two (2) Primavera P6 Enterprise Project Portfolio Management Scheduling Software licenses (registered to the Authority).
- H. Three Week Look Ahead Schedule: Submit first Three-Week Look Ahead Schedule at Pre-Construction Meeting. Submit three hard copies of the weekly thereafter at Construction Progress Meetings until Substantial Completion.

#### **1.06 SUBMITTAL DETAILS**

- A. Each submittal of Baseline, Preliminary and Progress Schedules shall include the elements listed herein.
- B. Electronic Data: Electronic transmittal containing schedule, schedule data, and narrative. Schedule data shall be saved in P6 (.xer) format and shall contain all files of the schedule that can be restored by the Authority for its evaluation and analysis.
  - 1. Tabular Reports: Electronic data submitted shall be sufficient to enable the Authority to generate the following tabular reports: Report sorted by activity number, report sorted by early start, and report sorted by total float. Data shall include the following items for each activity: activity number, description of what is to be accomplished and where, codes, duration, milestones, predecessor and successor logic, early start, early finish, late start, late finish, total float and free float.
- C. Gantt Activity Bar Charts: Show activities grouped by work areas and sorted by early start. Submit six (6) hard copies, 11 by 17 inch, and two (2) color E-size plots, 34 inches by 44 inches.
- D. Narrative Reports: Submit three hard copies.

**1.07 BASELINE SCHEDULE**

- A. Baseline Schedule shall utilize computerized Critical Path Method (CPM) network scheduling.
- B. Software: Utilize latest version of Primavera P6 Professional Project Management.



- C. Baseline Schedule shall show the order in which the Contractor proposes to carry out the work with logical links between work activities, and calculations made using the critical path method to determine the controlling operation or operations. Ensure that activity sequences are logical and that schedule shows a coordinated plan for complete performance of the work.
- D. Baseline Schedule shall include the entire scope of work through the end of Contract Time. Show how the Contractor plans to complete the Work. Show the activities that define the critical path. Show float on other activities. Keep multiple critical paths and near-critical paths to a minimum. A total of not more than 30 percent of the baseline schedule activities shall be critical or near critical, unless otherwise authorized by the Authority.
- E. The data date for the Baseline Schedule shall be the date of Limited Notice to Proceed (LNTP) and shall include actual dates and durations for work completed prior to Notice to Proceed (NTP). Baseline Schedule shall not attribute negative float or negative lag to any activity.
- F. Baseline Schedule shall define non-working days as the following 9 holidays: New Years Day, Martin Luther King Day, President's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Day after Thanksgiving Day and Christmas Day.
- G. Float: Float shall not be considered as time for the exclusive use of or benefit of either the Authority or the Contractor, but shall be considered as a jointly owned, expiring resource available to the project and shall not be used to the financial detriment of either party. Use of float suppression techniques such as preferential sequencing, special lead/lag logic restraints, extended activity durations or imposed constraints will be cause for rejection of the Baseline Schedule and subsequent Progress Schedules. The Contractor shall not create artificial activities that eliminate any or all float in the project schedule.
- H. Calendar: Utilize multiple schedule calendars to identify and differentiate between day and night shift work and any weekend activity work.
- I. Autocost rules: Autocost rules shall link the remaining duration and the schedule percent complete. The updated percent complete against the budget shall be used to estimate Actual Cost to Date, and Actual to Date shall be linked to Actual This Period. Other automatic cost/resource calculation rules shall be in a format acceptable to the Authority.
- J. Retained Logic: When schedule calculations are performed, the "Retained Logic" setting shall be used.
- K. Early Completion: The Contractor may submit a Baseline or Progress Schedule showing an early scheduled completion date provided that the requirements of the Contract are met.

1. The difference between the early completion date and the contract completion date is considered float. Float time shall not be for the exclusive benefit of either the Authority or the Contractor. Float shall be a resource available to both parties.
  2. Authority is not required to accept or approve a schedule with an early completion date.
  3. The Contractor shall not be entitled to extra compensation in the event an agreement is reached on an early completion date and the Contractor completes the Work, regardless of the reason, beyond the early completion date but within the Contract Time.
  4. Changes to Contract Time or contract completion date shall be by Contract Change Order.
- L. Baseline Narrative Report: Submit a narrative report with the Baseline Schedule describing the schedule development process, activity coding structure, basis of proposed durations, work sequence, approach or methods the Contractor intends to employ in the Work, and explanation of early scheduled completion date, if proposed.

#### **1.08 BASELINE SCHEDULE ACTIVITIES**

- A. Activity Coding: The Contractor shall develop its own activity coding structure. Activities shall be coded to a level sufficient to allow for multiple sorting such as that specified for tabular reports under "Tabular Reports" and "Gantt Activity Bars" in the Section entitled "Submittal Details" (1.06) herein.
- B. General Activity Requirements: Baseline schedules shall include activities to show the following, as applicable:
1. Project characteristics, salient features, or interfaces, including those with outside entities that could affect time of completion.
  2. Project start date, scheduled completion date and other milestones.
  3. Work performed by the Contractor, Subcontractors, Suppliers and Third Parties.
  4. Submittal development, delivery, review and approval, including those from the Contractor, Subcontractors, third parties, and suppliers which impact the critical path.
  5. All submittals as listed in the Schedule of Submittals.
  6. Procurement, delivery, installation, and testing of materials, plants, and equipment.
  7. Required delivery of Authority furnished materials and periods of use of Authority-furnished equipment.

8. Acquisition of permits.
  9. Utility notification and relocation noted to be performed by others.
  10. Installation and removal of falsework and shoring.
  11. Major traffic routing switches.
  12. Final cleanup.
  13. Work performed by other Contractors and entities.
  14. Demobilization, punchlist and project closeout activities.
- C. The number of activities shall be sufficient to assure adequate planning of the project, to permit monitoring and evaluation of progress, and to do an analysis of time impacts.
- D. Each schedule activity shall include the following:
1. A clear, legible and unique description, including the location of work.
  2. Start and finish dates.
  3. Duration not less than one full day, except for milestone activities, and not more than 15 working days, with the exception of submittals, fabrication, procurement, and summary activities, unless otherwise approved by Authority.
  4. At least one predecessor and one successor activity, except for project start and finish milestones.
  5. Contractually required constraints. Use of any other types of constraints is not allowed without prior approval by the Authority.
  6. Activity codes for responsibility, phase, area, stage, work shifts, and contract bid item numbers. Code for responsibility shall denote the entity performing the activity, i.e. Authority, Contractor, Subcontractor, or utility.
  7. Cost-Loading: Cost loading shall be made to the activities in accordance with the detail requirements set forth in this Section.

### **1.09 PRELIMINARY SCHEDULE**

- A. Preliminary 90-Day Construction Schedule shall be submitted to the Authority at Pre-Construction meeting. The Schedule shall contain all procurement, construction activities and the Contractor's intended sequencing of work for first 90 calendar days following LNTP or NTP, whichever occurs first. Accepted Preliminary 90-Day Schedule shall be updated monthly and submitted until the Contractor's Baseline Schedule is developed and accepted by Authority.

- B. Updates to Preliminary 90-Day Schedule are basis for payment to the Contractor during the first three-month period. Timely submittal and acceptance of such updates shall be a condition precedent to payment by Authority.
- C. Preliminary 90-Day Schedule shall also identify activities and milestones that will or may affect or be affected by activities of the Authority, Utilities, Railroads and other third parties.
- D. Partial cost loading for purpose of Progress and Earned Value Measurement as described in Section 1.11 covering the Work for first 90-Days after the LNTP or NTP shall be submitted with the Preliminary 90-Day Schedule.

#### **1.10 PROGRESS SCHEDULE**

- A. Progress Schedule shall consist of an updated schedule based on the Baseline Schedule.
- B. Release of Progress payments will be dependent on receipt of an acceptable Progress Schedule.
- C. Preliminary Progress Schedule: A Preliminary Progress Schedule for purpose of monthly progress review meeting is required 3 working days prior to the monthly status data date.
- D. For the detail procedures for Monthly Progress Review Meeting and the required formats for Preliminary Progress Schedule, refer to Section 1.11-A.
- E. Include the following information in the Progress Schedule: Status of work actually completed to date and the work yet to be performed as planned; actual activity start dates, and finish dates, as applicable; and durations for work that has been completed as the work actually occurred, including Authority submittal review and Contractor resubmittal times. Show approved time adjustments and project completion dates. Show approved Contract Change Order work. Show weather delay days which have already occurred and have been acknowledged by the Authority in writing.
- F. Modifications shown in Progress Schedule: The Contractor may include modifications such as adding or deleting activities or changing activity constraints, durations or logic that do not (1) alter the critical path(s) or near critical path(s) or (2) extend the scheduled completion date compared to that shown on the current accepted schedule. The Contractor shall state in writing the reasons for any changes to planned work. If any proposed changes in planned work will result in (1) or (2) above, then the Contractor shall submit a time impact analysis as described herein.
- G. Change logic relationships of out-of-sequence activities to reflect actual work sequence.
- H. Progress Narrative Report: Submit Narrative Report containing detailed comprehensive descriptions of the following information with every Progress Schedule submittal:

1. Description of work completed during the reporting period, including progress made on activities on the current critical path.
  2. Explanation of any lack of work on activities on the critical path during the reporting period.
  3. Description of the current critical path.
  4. Explanation of changes to the critical path, including changes to logic or activity durations, and scheduled completion date since the last schedule submittal. Include explanation of work activities performed out of sequence from the approved schedule.
  5. Status of major activities on the current critical path, including percent complete, and amount of time ahead or behind schedule. Provide description and explanation of any delays encountered during the reporting period, including impacts on other activities, milestones, and completion dates.
  6. Description of proposed corrective actions and schedule adjustments to mitigate delays and bring the project back on schedule.
  7. Status of permits, change orders, submittals, potential claims, time adjustments, material and equipment procurement, non-conformance reports, and any other pending items on the current critical path.
  8. Description of activities on the critical path to be performed in the next update period.
  9. Any other information pertinent to the status of the project as determined by the Contractor or requested by the Authority.
- I. Final Progress Schedule: Prepare and submit an updated, as-built Progress Schedule with actual start and finish dates for all activities and documented changes from the Preliminary Progress Schedule. Include a narrative report. The Contractor shall provide a written certificate with this submittal signed by the Contractor's project representative and an officer of the company stating, "To my knowledge and belief, the enclosed final update schedule reflects the actual start and finish dates of the actual activities for the project contained herein." An officer of the company may delegate in writing the Authority to sign the certificate to a responsible manager.

### **1.11 PROGRESS AND EARNED VALUE MEASUREMENT**

- A. As a part of the monthly update cycle, a progress review meeting utilizing the Preliminary Update Schedule, will be held at least 3 working days prior to the data date between the Contractor and the Authority.
1. The schedule shall be based on the approved Progress Schedule from the previous month.

2. The format shall include added blank columns in which the Contractor will pencil in the updated information including start dates, finish dates, percent completes, and remaining durations. The Contractor shall indicate activities for which Physical Percent Complete is used. The anticipated actual progress between the meeting date and the data date shall also be projected and included in the Preliminary Update Schedule. The format for the draft update schedule is shown below.

← Previous Period → ← This Period →											
Activity ID	Activity Description	OD	RD	%	Early Start	Early Finish	%	RD	Start	Finish	Comments
<b>02720.2 STORM DRAINS - YARD</b>											
<b>02720.2.04 18" PVC SD PIPE, 11' INV</b>											
0470	Exc/Lay/BF 18" SD Line A 25+48 to 27+95	3	0	100	23APR08A	24APR08A					
0580	Exc/Lay/BF 18" SD Line C 29+62 to 30+00	1	0	100	13MAY08A	13MAY08A					
0540	Exc/Lay/BF 18" SD Line B 21+29 to 27+50	4	2	50	27MAY08A	04AUG08	100	0		10AUG08	
0545	Exc/Lay/BF 18" SD Line B 27+50 to 27+90	1	0	100	29JUL08A	31JUL08A					
0630	Exc/Lay/BF 18" SD @ Laurel	4	4	0	07AUG08	12AUG08	50	3	09AUG08		Physical %
Subtotal		79	8	54	23APR08A	12AUG08					

3. Any logic revisions that need to be incorporated into the Progress Schedule shall be brought to the Authority's attention in the monthly progress review meeting for Authority's initial review, including, but not limited to, fixing the logic of out-of-sequence activities, adding any approved time impact fragnets, reflecting the Contractor's work plan changes, and any other minor logic revisions.
- B.
- Except as otherwise specified, only construction and general requirement activities shall be cost loaded. The sum of the budgeted costs of all activities in the project schedule shall equal the contract price. Activity costs shall not be input as resources.
    1. Each construction activity shall have a nonzero budgeted cost that represents the direct cost of the work. Front-end loading of costs is not permitted and shall result in rejection of the schedule.
    2. In the scheduling software, cost account numbers shall be defined to exactly mirror the contract bid item numbers. All activities shall be assigned with a cost account number which corresponds to the contract bid item number whether or not the activity has a dollar value assigned. The sum of the budgeted cost of all activities coded with a particular cost account (i.e., sub-level activities under a particular bid item) shall equal to the amount of the matching bid item.
    3. Each activity's cost loading should be made based on the predefined cost account numbers so that a Schedule of Value report can be generated from the scheduling software after the entire cost loading is done. The format of the Schedule of Value shall be the same as the Schedule of Quantities of Price in the contract document.

4. Activity's percent complete shall be determined by estimating percent of Work in place. Autocost rule shall link Remaining Duration and Percent Complete. If the Contractor elects to bypass the said autocost rule for any cost loaded activities by using Physical Percent Complete or any other variations, a prior approval from the Authority shall be obtained.
- C. The amount of monthly progress payment shall match the sum of the Earned Values generated from the cost loaded activities as a result of updating the Progress Schedule.
1. The organization of Earned Value Report shall be the same as the breakdown of Schedule of Value submitted during the initial schedule development which was developed according to predefined cost account numbers corresponding to the contract bid item numbers.
  2. The Schedule of Value shall be the base from which an Earned Value Report will be generated each month. The Earned Value Report shall be attached to each monthly payment application submittal package.
- D. After the monthly progress review meeting, the Contractor shall formally update the monthly Progress Schedule based on the agreed-upon schedule update data. Then the monthly Earned Value Report shall be generated and included in the monthly Progress Schedule submittals, which shall be submitted no later than 5 working days after the data date. The Earned Value Report shall be a direct output from the scheduling software which shows subtotal for each Schedule of Value grouping category and grand total for the entire project. The Earned Value Report format is shown below.

Activity ID	Activity Description	Budgeted Cost	%	Previous Actual \$	This Period \$	Actual \$ to Date	Cost to Complete	Cost at Completion
<b>02720.2 STORM DRAINS - YARD</b>								
<b>02720.2.04 18" PVC SD PIPE, 11' INV</b>								
0470	Exc/Lay/BF 18" SD Line A 25+48 to 27+95	20,000.00	100	20,000	0	20,000.00	0.00	20,000.00
0580	Exc/Lay/BF 18" SD Line C 29+62 to 30+00	17,812.00	100	10,000	7,812	17,812.00	0.00	17,812.00
0540	Exc/Lay/BF 18" SD Line B 21+29 to 27+50	20,000.00	50	5,000	5,000	10,000.00	10,000.00	20,000.00
0545	Exc/Lay/BF 18" SD Line B 27+50 to 27+90	10,000.00	100	3,000	7,000	10,000.00	0.00	10,000.00
0630	Exc/Lay/BF 18" SD @ Laurel	4,400.00	0	0	0	0.00	4,400.00	4,400.00
Subtotal		72,212.00	80	38,000	19,812	57,812.00	14,400.00	72,212.00

**1.12 THREE-WEEK LOOK AHEAD SCHEDULE**

- A. Three-Week Look Ahead Schedule shall contain one week of historical information and three weeks of planned activities in support of and consistent with the Baseline Schedule or current Progress Schedule.
- B. Format: An electronic spreadsheet or other format acceptable to the Authority. Label each activity to match the Activity ID number on the current Progress Schedule. Highlight the critical path. Data date shall be within current week.
- C. Level of Detail: Greater than in the Baseline Schedule or Progress Schedule.

- D. Clearly show each activity requiring track access during specified work windows; schedule activities performed during single or multiple track outage work windows utilizing an hourly time scale.
- E. Show weather delay days which have already occurred and have been acknowledged by the Authority in writing.
- F. Show demobilization and punchlist activities through to Final Completion.

### **1.13 REVIEW AND RESUBMITTALS**

- A. The Authority will review and return the Contractor's schedule submittals and deliverables with a written response according to the following schedule from the date of receipt from the Contractor.
  - 1. Baseline Schedule: within 15 working days.
  - 2. Progress Schedule: within 10 working days
- B. The Authority will review and return resubmittals to the Contractor with a written response according to the following schedule from the date of receipt from the Contractor.
  - 1. Baseline Schedule: within 15 working days
  - 2. Progress Schedule: within 10 working days
- C. If the Contractor does not agree with the Authority's comments, provide written notice of disagreement within 5 working days from the receipt of the Authority's comments. Resolve any Authority's comments with which the Contractor disagrees in a meeting held for that purpose.
- D. The first of each type of submittal and deliverable submitted by the Contractor will be reviewed for format, as well as content. The Authority may require format changes. Once the format has been approved, submit subsequent submittals and deliverables in the approved format.
- E. Baseline Schedule Review Meeting: Within 10 working days after the submittal of the Baseline Schedule, the Authority will conduct a Baseline Schedule Review Meeting with the Contractor.
  - 1. The Contractor shall have its Project Manager, construction management personnel, individual performing scheduling and major Subcontractor representatives, in attendance.
  - 2. Meeting topics will include the following:
    - a. The Contractor's presentation of Baseline Schedule submittal including explanation of critical path, critical path activities, resources and production rates of work activities, and other items related to scheduling of work.



- b. General review and discussion of schedule format, activities and information potentially missing from the schedule.
- F. Recovery Schedule: If Contractor's actual progress of the Work falls ten (10) working days behind the approved Baseline Schedule for the Contract completion date, the Contractor shall prepare and submit a Recovery Schedule within five (5) working days to explain and display how the Contractor intends to regain compliance with the Contract completion date. The Recovery Schedule shall detail the Contractor's plan for bringing the work back on schedule. The Contractor's plan for recovery shall conform to all other Contract requirements. Incorporate revisions accepted by the Authority in the next Progress Schedule. Do not incorporate proposed revisions in the Progress Schedule prior to their acceptance.

#### **1.14 TIME IMPACT ANALYSIS**

- A. If the Contractor requests an extension of time for the completion of an interim milestone date or Contract completion date, justification in the form of a Time Impact Analysis (TIA) for such extension shall be furnished. The Authority will determine whether or not the Contractor is entitled to an extension of time under the provisions of the Contract. Submission of a TIA based on revised activity logic, duration, and a cost is required for approval of any time extension. The cost of preparing time impact analyses or subsequent schedule revisions shall be borne solely by the Contractor.
- B. Illustrate the impacts of each change or delay on the current Contract completion date or interim milestone, as appropriate. Use the approved Progress Schedule which has a data date closest to and prior to the event for which an extension is being requested.
- C. Include a schedule showing all schedule logic revisions, duration changes, cost changes, and additions or deletions of activities for the work in question and its relationship to other activities on the Progress Schedule. Provide additional supporting evidence if requested by the Authority.
- D. The Authority's determination as to the total number of days of time extension will be based upon the current schedule for the time period in question, and all other relevant information. Actual delays in activities which, according to the Progress Schedule, do not affect the critical path or the Contract completion date will not be the basis for a time extension.
- E. The Authority will review the facts and advise the Contractor in writing of the Authority's decision. If the Authority determines that the Contractor is entitled to an extension of time to an interim milestone, the Contract completion date will remain the same, unless the Authority specifies another date. Any change to Contract milestones or to the Contract completion date will be made by Change Order.

- F. If the Authority has not yet made a full determination as to the amount of time extension to be granted and the parties are unable to agree as to the amount of extension to be reflected in the Progress Schedule, reflect that amount of time extension in the Progress Schedule as determined to be appropriate by the Authority for such interim purpose. It is understood and agreed that such interim determination by the Authority for the purposes of this Section will not be binding upon either party for any other purpose, and that, after the Authority has made a final determination as to any time extension, revise the Progress Schedule in accordance with the final decision.

#### **1.15 INCLEMENT WEATHER CONDITION**

The Contractor shall allow for inclement weather in the Baseline Schedule by incorporating an activity titled "Rain Day Impact Allowance" as the last activity prior to the Substantial Completion milestone. No other activities may be concurrent with it. The duration of the Rain Day Impact Allowance activity will be based on Section 01 31 99, Period of Performance.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 32 17**

## SECTION 01 32 33

### PHOTOGRAPHIC DOCUMENTATION

#### 1.01 SUMMARY

This Section includes administrative and procedural requirements for the following:

- A. Preconstruction photographs
- B. Periodic construction photographs
- C. Final completion construction photographs
- D. Preconstruction video recordings
- E. Periodic construction video recordings
- F. Web-based construction photographic documentation

#### 1.02 RELATED REQUIREMENT

- A. Section 01 33 00, Submittal Procedures
- B. Section 01 77 00, Substantial Completion

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit a key plan of the Project site and any buildings, with notation of vantage points marked for location and direction of each photograph and video recording. Indicate the elevation of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within 7 days of taking photographs.
  - 1. Digital Camera: Minimum sensor resolution of 5 megapixels.
  - 2. Format: Minimum of 1,600 by 1,200 pixels and 400 dpi, in unaltered JPG format original files having the same aspect ratio as the sensor, uncropped, date- and time-stamped, in a folder named by the date of the photographs, and accompanied by a key plan file.
  - 3. Identification: Provide the following information with each image description using file metadata tags:
    - a. Date stamped by digital camera
    - b. Description of the vantage point, indicating location, direction (by compass point), and elevation or story of construction
    - c. Unique sequential identifier keyed to the accompanying key plan
- C. Video Recordings: Submit video recordings within seven days of recording.

1. Submit video recordings in a digital format acceptable to the Authority.
2. Identification: With each submittal, provide the following information:
  - a. Name of the Project
  - b. Name of the Contractor
  - c. Date video recording was recorded
  - d. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction

## **PART 2 - PRODUCTS**

### **2.01 PHOTOGRAPHIC MEDIA**

- A. Digital Images: Provide images in JPG format, produced by a digital camera with a minimum sensor size of 10 megapixels, and at an image resolution of not less than 1,600 by 1,200 pixels and 400 dpi.
- B. Digital Video Recordings: Provide a high-resolution, digital video in a format acceptable to the Authority.

## **PART 3 - EXECUTION**

### **3.01 CONSTRUCTION PHOTOGRAPHS**

- A. General: Take photographs using the maximum range of depth of field, producing images that are in focus so as to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
- B. Maintain a key plan with each set of construction photographs that identifies each photographic location.
- C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or any modifications using image-editing software.
  1. Date and Time: Include date and time in file name for each image.
  2. Field Office Images: Maintain one set of images accessible in the field office at the Project site, available at all times for reference. Identify images in the same manner as used for those submitted to the Engineer.
- D. Preconstruction Photographs: Before commencement of construction, take photographs of the Project site and surrounding properties including existing items that are to remain during construction. These photographs shall be taken from different vantage points, as directed by the Authority.
  1. Flag construction limits before taking construction photographs.

2. Take photographs to show existing conditions adjacent to the property before starting the Work.
  3. Take photographs of existing buildings either on or adjoining the property to accurately record physical conditions at start of construction.
  4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- E. Periodic Construction Photographs: Take photographs at a minimum weekly, with the timing each month adjusted to coincide with the cutoff date associated with each Application for Payment. Select vantage points to show the status of construction and progress since the last photographs were taken.
1. Commencement of the Work, through completion of clearing of site, demolition, and dismantling and removals
  2. When excavation is complete
  3. When utility pipes, conduits, and ducts are installed but not covered
  4. When footings and foundations are complete
  5. When the subgrade is complete
  6. When geomat and ballast are placed
  7. When rail and special track is installed
  8. Earth box and switch excavation and installation
  9. TPSS and C/S prefab building installation
  10. All above-grade structural framing
  11. Exterior building enclosure
  12. Interior Work, through the date of Substantial Completion
  13. When finish grade is complete
  14. Site improvements through date of Substantial Completion.
  15. Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
- F. Final Completion Construction Photographs: Take color photographs after the date of Substantial Completion for submission as Project record documents.

### 3.02 CONSTRUCTION VIDEO RECORDINGS

- A. Recording: Mount the camera on a tripod before starting recording, unless otherwise necessary to show the construction area. Display continuous running time and date.
- B. Narration: Describe scenes on the video recording by audio narration, using a microphone while the video is recorded. Include a description of items being viewed, recent events, and planned activities. At each change in location, describe the vantage point, location, direction (by compass point), and elevation or story of construction.
  - 1. Confirm date and time at beginning and end of recording.
  - 2. Begin each video recording with the name of the Project, the Contractor's name, the videographer's name, and the Project location.
- C. Preconstruction Video Recording: Before starting construction, make a video recording of the Project site and surrounding properties from different vantage points.
  - 1. Flag construction limits before recording construction video recordings.
  - 2. Show existing conditions adjacent to the Project site before starting the Work.
  - 3. Show existing buildings, structures, and peripheral improvements either on or adjoining the Project site to accurately record physical conditions at the start of construction.
  - 4. Show protection efforts undertaken by the Contractor.
- D. Periodic Construction Video Recordings: Make video recordings monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show the status of construction and progress since the last video recordings were made.

### PART 4 - MEASUREMENT AND PAYMENT

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 32 33**

## SECTION 01 33 00

### SUBMITTAL PROCEDURES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes requirements for the submittal schedule and procedural requirements for submitting Shop Drawings, Product Data, Samples, administrative and miscellaneous (non-administrative) work-related submittals.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 25 00, Substitution Procedures
- B. Section 01 60 00, Product Requirements
- C. Section 01 78 39, Project Record Documents

##### 1.03 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require the Authority's responsive action. Action submittals are those submittals indicated in individual Specification Sections as action submittals.
- B. Informational Submittals: Written and graphic information and physical samples that do not require a response from the Authority. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals so described in individual Specification Sections.
- C. Plans and Procedures: Shall include, but are not limited to, narrative descriptions, diagrams, equipment, procedures for excavation, demolition, site clearing, maintenance of traffic, etc.
- D. Certificates: Shall include, but are not limited to, certified material test reports, certification of proper disposal of demolition materials, or tickets demonstrating compliance with materials, tests or Specifications indicated.
- E. Equipment: Shall include, but is not limited to, equipment Specifications, manufacturer information and demonstration of suitability of equipment for intended use.
- F. Product Data: Shall include, but is not limited to, standard printed information on materials, products and systems to be furnished by the Contractor for this Contract.
- G. Shop Drawings: Shall include, but are not limited to, detailed manufacturing and layout information, demonstrating the Contractor's approach to meeting the intent of the Plans and Specifications.
- H. Samples: Include physical examples of materials either for limited visual inspection or (where indicated) for confirmation, testing, and analysis by the Authority.

- I. **Miscellaneous Submittals:** Such submittals shall be related directly to the Work, but not necessarily administrative related. Include Work schedule, phasing plans, warranties, guarantees, maintenance agreements, workmanship bonds, survey data and reports, physical work records, quality testing and certifying reports, copies of industry standards, record drawings, field measurement data, operating and maintenance Materials, overrun stock (and similar information) and, devices and Materials applicable to the Work but not processed as Shop Drawings, Product Data or samples.

#### **1.04 PATENTS**

In the event that any patented article, material, or process is to be installed or used in the performance of the Work as shown on the drawings or particular specifications thereof, the Contractor shall pay the royalty chargeable and shall save, keep, and bear the Authority harmless from (a) all damage, costs, and expenses by reason of any infringement of the patent or any failure to pay the royalty chargeable for use thereof, or (b) any loss to the Authority in the event that the Authority is enjoined from using such patented article or material, or (c) the incidental damage caused by the loss of use and damage to Authority property in removing same, and (d) the cost of replacing the article or material the use of which is enjoined. It is further provided that the Bond for faithful performance shall be deemed to expressly apply to this provision of the specifications.

#### **1.05 CONTRACTOR PREPARED DRAWINGS, PRODUCT DATA, AND SAMPLES**

The Contract Documents shall be supplemented by shop drawings, working drawings, equipment layout drawings, coordination drawings, lift drawings, product data, samples, and similar submittals prepared by the Contractor or its Subcontractors or Suppliers, of any tier. These materials and similar submittals shall be furnished as required for coordination of the Contractor's work, as required for the coordination of the work with forces of the Authority or other Contractors working for the Authority, as required by the various sections of the specifications, or as requested by the Authority. The purpose of the submittal is to demonstrate for those portions of Work for which submittals are required the manner in which the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

When shop drawings, working drawings, equipment layout drawings, coordination drawings, lift drawings, product data, samples or similar submittals are required by any section of the specifications or have been requested by the Authority or the Engineer, the Contractor shall coordinate all Work under the various sections of the Specifications to ensure that no interferences occur in the areas, structures, or rooms for which such drawings have been required, and that necessary clearances are provided.

#### **1.06 SUBMITTAL SCHEDULE**

Submit a schedule of submittals, arranged in chronological order by dates required by the construction schedule. When establishing dates, include the time required for review, ordering, manufacturing, fabrication, and delivery. Include additional time required for making submittal corrections or modifications noted by the Authority, and additional time for handling and reviewing submittals required by those corrections.

- A. The Contractor may not begin the work prior to delivery of the submittal schedule.



- B. Coordinate the submittal schedule with the list of subcontracts, the Schedule of Values, and the Contractor's construction schedule.
- C. Submit Initial Submittal Schedule 15 days after issuance of Limited Notice to Proceed. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work, and those required early because of long lead time for manufacture or fabrication. Indicate if a submittal is on the critical path for project completion.
- D. Final Submittal: Submit concurrently with the first complete submittal of the Contractor's construction schedule. Submit a revised submittal schedule to reflect changes in the current status and timing for submittals.
- E. Format: Arrange the following information in a tabular format:
  - 1. Scheduled date for first submittal
  - 2. Specification Section number and title
  - 3. Submittal category (action or informational)
  - 4. Name of Subcontractor
  - 5. Description of the Work covered
  - 6. Scheduled date for the Authority's final release or approval
  - 7. Scheduled dates for purchasing
  - 8. Scheduled dates for delivery and installation
  - 9. Activity or event number
  - 10. Float

#### **1.07 PROCESSING REQUIREMENTS FOR SUBMITTALS**

- A. General: Electronic digital copies of CAD drawings of the Contract Drawings (Plans) will be provided by the Authority for the Contractor's use in preparing submittals, subject to completion and return of the Authority's release form.
  - 1. Each submittal shall only contain items from one specification section, and duplicate submittals will not be accepted.
  - 2. Any submittal returned as incomplete, or improperly formatted shall not be counted as starting Processing Time.
- B. Coordination: Coordinate preparation and processing of submittals with the performance of construction activities. Transmit each submittal sufficiently in advance of related construction activities to avoid delay (no less than 14 days).
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on an approved submittal schedule.
  3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
  4. Coordinate the transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of the need to review submittals concurrently for coordination.
  5. The Contractor shall show his executed internal review and approval marking. Submittals, which are received from sources other than through the Contractor's office or which have not undergone Contractor review, will be returned marked "without action."
  6. The Authority reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on the first full working day after the Authority receives the submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. In the event that Submittal is reviewed by a third party (including Railroads Operators and authorities having jurisdiction), allow up to an additional 14 working days' time for Authority's response. The Authority will advise the Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in the same manner as an initial submittal.
  3. Resubmittal Review: Allow seven days for review of each resubmittal.
  4. Concurrent Consultant and/or Agency Review: Where concurrent review of submittals is required, allow 21 days for initial review of each submittal.
  5. Submittals received after 2 PM will not be processed until the following working day which will be recorded as the receipt of submittal date.
- D. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using transmittal form. The Authority will return, without review, any submittals received from sources other than the Contractor.
1. Transmittal Form provided: Populate locations on the form with the following information:
    - a. Project name

- b. Date
  - c. Source (From:)
  - d. Names of Subcontractor, manufacturer, and supplier
  - e. Category and type of submittal
  - f. Submittal purpose and description
  - g. Specification Section number and title, sub section
  - h. Indication of full or partial submittal
  - i. Drawing number and detail references, as appropriate. Absence of drawing number will be cause for rejection of submittal.
  - j. Transmittal number, numbered consecutively
  - k. Submittal and transmittal distribution record
  - l. Remarks
  - m. Signature of transmitter
2. On an attached separate sheet, prepared on the Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by the Authority on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include the same identification information as on the related submittal.
  3. Include the following information as keywords in the electronic file metadata:
    - a. Project name
    - b. Project Identification Number
    - c. Number and title of the appropriate Specification Section
    - d. Manufacturer name
    - e. Product name
- E. For electronic submittal Identification and Information, incorporate in each file as follows:
1. Assemble the complete submittal package into a single bookmarked file, relevant bookmarks to sections and subsections.

2. Name the file with its submittal number or another unique identifier, including revision identifier. The file name shall use a project identifier and the Specification Section number, followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
  3. Provide a means for insertion to permanently record the Contractor's review and approval markings and action taken by the Authority.
- F. Identify Applicable standards, ASTM, ACI, OSHA, etc. and identify options requiring selection by the Authority.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
- H. Resubmittals: Make resubmittals in the same form and with the same number of copies as the initial submittal.
1. Note the date and content of the previous submittal.
  2. Note the date and content of the revision in the label or title block, and clearly indicate the extent of revision.
  3. Resubmit submittals until they are stamped with action by reviewer.
- I. Distribution: Furnish copies of final submittals to manufacturers, Subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on the transmittal forms.
- J. Use for Construction: Retain full copies of approved submittals on the Project Site. Use only final submittals that are marked with approval notation from the Engineer's action stamp.

#### **1.08 SUBMITTAL REQUIREMENTS FOR COMMISSIONING**

- A. Normal Submittals:
1. Submit copy of normal submittals for equipment to be commissioned to the Authority.
  2. Authority will review and approve normal submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the Authority's review.
- B. Data for Commissioning: Authority will request specific information needed about each piece of commissioned equipment or system. Information requested includes, but is not limited to, the following:
1. Detailed manufacturer's installation and start-up procedures
  2. Operating, troubleshooting, and maintenance procedures
  3. Full details of Authority-contracted tests, if any

4. Fan and pump curves
  5. Full factory testing reports, if any
  6. Full warranty information, with responsibilities of the Authority to keep warranty in force clearly defined
  7. Installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms to be used by factory or field technicians
- C. Authority may request additional documentation necessary for the commissioning process. Requests by Authority may precede, be concurrent with, or follow normal submittals.
- D. The Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved by Authority's review.

### **1.09 CONFORMANCE OF SUBMITTALS**

- A. The Contractor is responsible for conformance of all submittals prepared by the Contractor or its Subcontractors or suppliers, of any tier, with all requirements of the Contract Documents. Where required by California law, or as specified in the Contract Documents, submittals shall be signed and sealed by a Professional Engineer licensed in the State of California, or Land Surveyor licensed in the State of California as applicable.
- B. The Contractor shall show his executed internal review and approval marking. Submittals, which are received from sources other than through the Contractor's office or which have not undergone Contractor review, will be returned marked "without action."
- C. Acceptance of shop drawings, working drawings, equipment layout drawings, coordination drawings, lift drawings, product data, samples, and similar submittals shall not relieve the Contractor from responsibility for deviations from the Contract Documents, nor from responsibility for errors or omissions of any sort with such drawings and data. Neither shall the acceptance of such drawings and data by the Authority relieve the Contractor from responsibility for the correct installation, or for the proper operation in service, of items requiring submittal of such drawings and data.

## **PART 2 - PRODUCTS**

### **2.01 SUBMITTAL PERFORMANCE REQUIREMENTS**

- A. Any Work performed without an approved submittal will be done at the Contractor's own risk

- B. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Authority's review of Shop Drawings, Product Data, Samples, or similar submittals unless the Contractor has specifically informed the Authority in writing of such deviation at the time of the submittal and given written acceptance to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals by the Authority's review thereof.
- C. Direct specific attention in writing or on resubmitted shop Drawings, Product Data, Samples, or similar submittals to revisions other than those requested by the Authority on previous submittals.

## 2.02 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. The required types of submittals are indicated in individual Specification Sections.
  - 1. Submit electronic submittals via e-mail as PDF electronic files. The Authority will return a response via e-mail. Contractor shall retain a copy of file as an electronic Project record document file.
  - 2. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 19, Project Closeout.
  - 3. Certificates and Certifications Submittals: Provide a statement that includes the signature of the entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity who is an Engineer or Architect recognized to practice engineering or architecture in the State of California.
  - 4. Test and Inspection Reports Submittals: Comply with requirements specified in Section 01 40 00, Quality Requirements.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment. A Material Safety Data Sheet shall be submitted for each product.
  - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each submittal clearly to show which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts
    - b. Manufacturer's product specifications
    - c. Standard color charts

- d. Statement of compliance with specified referenced standards
  - e. Testing by recognized testing agency
  - f. Application of testing agency labels and seals
  - g. Notation of coordination requirements
  - h. Availability and delivery time information
  - i. Manufacturer's written recommendations
  - j. Manufacturer's installation instructions
  - k. Mill reports
  - l. Standard product operation and maintenance manuals
  - m. Approval number of organizations or agencies as required by agencies having jurisdiction
  - n. Notation of dimensions verified by field measurements
  - o. Notation of coordination requirements
4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams showing factory-installed wiring
    - b. Performance curves
    - c. Operational range diagrams
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings
  5. Submit Product Data concurrent with Samples, identify Sample and indicate location of installation.
  6. Submit Product Data as a PDF file.
- C. Shop Drawings, Working Drawings, Equipment Layout Drawings, and Coordination Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on the Engineer's digital data drawing files is otherwise permitted. Unless otherwise approved by the Authority or indicated in specific sections of the Specifications, Shop Drawings shall be scaled sufficiently large to accurately show all pertinent aspects of the item and its relationship to the Work. The Contractor shall additionally submit the shop drawing on electronic media in MicroStation Intergraph Format version acceptable to the Authority.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

- a. Identification of products
  - b. Product Schedules
  - c. Compliance with specified standards
  - d. Notation of coordination requirements
  - e. Notation of dimensions established by field measurement
  - f. Relationship and attachment to adjoining construction clearly indicated
  - g. Seal and signature of California registered professional engineer if specified
  - h. Dimensions and clearances
  - i. Fabrication and installation drawings
  - j. Roughing-in and setting diagrams
  - k. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring
  - l. Templates and patterns
  - m. Design calculations
  - n. Approval number of organizations or agencies with jurisdiction for the Work.
2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 11 by 17 inches but no larger than 24 by 36 inches.
  3. Submit Shop Drawings as a PDF file.
- D. Samples: Submit full-size units or Samples of the size indicated, prepared from the same material to be used for the Work, cured and finished in the manner specified, physically identical with the material or product proposed for use, and showing the full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
1. Transmit Samples that contain multiple, related components (such as accessories) together in one submittal package.
  2. Identification: Attach a label on the unexposed side of Samples that includes the following:



- a. Generic description of Sample
  - b. Product name and name of manufacturer
  - c. Sample source
  - d. Number and title of applicable Specification Section
3. Disposition: Maintain sets of approved Samples at the Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
- a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
  - b. Samples not incorporated into the Work, or otherwise designated as Authority's property, are the property of the Contractor.
4. Detailed Work drawings for Samples shall be submitted by the Contractor for temporary structures and for such other temporary Work that may be required for construction of other permanent work. Submittals shall include back-up calculations or any information needed to explain the structure or system or its intended use.
5. Where a submittal involves engineering computations or original design Work is depicted, the submittal shall show the name, the State of California registration number, seal, and signature of the Professional Engineer certifying that such computations or design Work are correct and in conformance with standards, codes, and acceptable engineering practice.
6. Number of Initial Selection Samples: Submit four full sets of available choices where color, pattern, texture, or similar characteristics are required to be selected from a manufacturer's product line. The Authority will return the submittal with options selected.
7. Number of Verification Samples: Submit four sets of Samples. Mark up and retain one returned Sample set as a Project record sample.
- a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
  - b. If variations in color, pattern, texture, or other characteristics are inherent in the material or product represented by a Sample, submit at least four sets of paired units that show the approximate limits of the variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating the types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include a unique identifier for each product.
  2. Manufacturer and product name, and model number if applicable.
  3. Number and name of room or space.
  4. Location within room or space.
  5. Submit the product schedule as a PDF file.
- F. Certificates of Compliance: Certificates of Compliance shall be submitted by the Contractor to the Authority for those Materials and products for which no samples and test results are specified. The certificates shall:
1. State that the product complies with the respective Contract Specification and Contract Drawing requirements.
  2. Be accompanied by a certified copy of test results pertaining to the product. All test equipment used shall be verified to be in calibration at the time of each test and test reports shall so indicate. No test shall be made without such verification. When required by the Contract Documents or by law, certified test results shall be sealed by a Professional Engineer licensed to practice in the State of California.
  3. Show product represented and its location in the Contract, producer's name, product trade name and catalog number as applicable, place of product origin, test date, testing organization's name and address, quantity of the product to be furnished, and the related Contract Drawing and Specification section numbers.
- G. Where required by the Specification or if requested by the Authority, submit the following written statements on the manufacturer's letterhead:
1. Certification that the manufacturer, its products or materials complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
  2. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results verifying the material's compliance with requirements in the Contract Documents.
  3. Product Test Reports: Submit written reports indicating the current product produced by the manufacturer complies with requirements in the Contract Documents. Base reports on an evaluation of tests performed by the manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
  4. Research Reports: Submit written evidence, from a model code organization acceptable to jurisdictional authorities that the product complies with the building code in effect for the Project. Include the following information:

- a. Name of evaluation organization
  - b. Date of evaluation
  - c. Time period when report is in effect
  - d. Product and manufacturers' names
  - e. Description of product
  - f. Test procedures and results
  - g. Limitations of use
5. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of the product to determine compliance with performance requirements in the Contract Documents.
  6. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
  7. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of the product or after the product is installed in its final location to verify compliance with requirements in the Contract Documents.
  8. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, a list of applicable codes and regulations, and calculations. Include a list of assumptions and other performance and design criteria, and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
  9. Manufacturer's Instructions: Prepare written or published information that documents the manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include the name of the product and the name, address, and telephone number of the manufacturer. Include the following, as applicable:
    - a. Preparation of substrates
    - b. Required substrate tolerances
    - c. Sequence of installation
    - d. Required installation tolerances
    - e. Required adjustments
    - f. Recommendations for cleaning and protection

10. Manufacturer's Field Reports: Prepare written information documenting the factory-authorized service representative's tests and inspections. Include the following, as applicable:
  - a. Name, address, and telephone number of the factory-authorized service representative making the report
  - b. Statement on condition of substrates and their acceptability for installation of product
  - c. Statement that products at Project site comply with requirements
  - d. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken
  - e. Results of operational and other tests and a statement of whether observed performance complies with requirements
  - f. Statement whether conditions, products, and installation will affect warranty
  - g. Other required items indicated in individual Specification Sections

## **PART 3 - EXECUTION**

### **3.01 CONTRACTOR'S REVIEW**

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with an approval stamp before submitting to the Authority.
- B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Section 01 77 19, Project Closeout.
- C. Approval Stamp: Stamp each submittal with a uniform approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that the submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

### **3.02 AUTHORITY'S ACTION**

- A. The Authority will not review submittals that do not bear the Contractor's approval stamp, and will return such submittals without action.
  1. The review is not conducted for the purpose of determining the accuracy and completeness of other details, such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor.

2. Compliance with specified characteristics is the Contractor's responsibility; it is not considered part of the Authority's review and indication of action taken.
  3. Acceptance of submittals with deviations shall not relieve the Contractor from responsibility for additional costs of changes required to accommodate such deviations. Deviations included in submittals without prior acceptance are excepted from review of submittals, whether noted or not on returned copy.
  4. Review of a separate item shall not indicate acceptance of the assembly of which the item is a part.
  5. Make only those revisions required or accepted by the Authority.
  6. Notations by the Authority which increase Contract Cost or Contract Time shall be brought to the Authority's attention, in writing as a Request for Change, before proceeding with Work.
  7. When professional certification of performance criteria of materials, systems, or equipment is required by the Contract Documents, the Authority shall be entitled to rely on the accuracy and completeness of such calculations and certifications.
- B. Action Submittals: The Authority will review each submittal, make marks to indicate corrections or modifications required, and return it. The Authority will stamp each submittal with an action stamp and mark the stamp appropriately to indicate the action required.
- C. Informational Submittals: The Authority will review each submittal and will generally not return it (it will be returned if it does not comply with requirements). The Authority will forward each submittal to the appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from the Authority.
- E. Incomplete submittals are not acceptable; they will be considered nonresponsive, and will be returned without review.
- F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

### **3.03 SUBMITTAL STATUS**

- A. Submittals reviewed by the Authority and returned to the Contractor will be marked with one of the following designations:
1. No Exceptions Taken.
  2. Approved as Noted.
  3. Revise and Resubmit.
  4. Rejected.

5. No Action Taken.

- B. The Contractor shall not proceed with procurement, manufacture or fabrication of items submitted for review, until such submittals have been designated by the Authority as "No Exceptions Taken" or "Approved as Noted." Until submittal items receive such designation by the Authority, any costs associated with procurement for these items shall be at the Contractor's risk.

**3.04 SUBMITTALS DESIGNATED AS "CONFORMS" OR "CONFORMS WITH CORRECTIONS AS NOTED"**

- A. The submittal so designated by the Authority will be identified accordingly by being so stamped and dated and returned to the Contractor.
- B. The Contractor shall take responsibility for and bear all cost of damages, which may result from the ordering of any material or from proceeding with any part of the Work prior to being marked "No Exceptions Taken" or "Approved as Noted" by the Authority.
- C. Where drawings are stamped "Approved as Noted", the Authority shall indicate the corrected detail or information as required.
- D. Submittals stamped "NO Exceptions Taken" do not relieve the Contractor from the responsibility of performance of Work as intended in the Plans and Specifications.

**3.05 SUBMITTALS DESIGNATED AS "REVISE AND RESUBMIT," OR "REJECTED. RESUBMIT"**

- A. The submittal so designated by the Authority will be identified accordingly by being so stamped and dated and returned to the Contractor.
- B. If corrections to the submittals are required, the submittals will be returned to the Contractor will be marked "Rejected, Resubmit", or "Revise and Resubmit" and the required corrections shall be made on the re-submittal.
- C. Re-submittals will be processed in the same manner as first submittals. On every re-submittal, the Contractor shall note any revisions other than the corrections requested by the Authority on previous submittals. Re-submittals shall use the same number as original submittal but will be modified by R and number of re-submittals in the suffix.
- D. The Contractor shall notify the Authority prior to execution of any correction, which constitutes a change of the Contract requirements indicated on the submittals.

**3.06 SUBMITTALS DESIGNATED AS "NO ACTION TAKEN"**

- A. The submittal so designated by the Authority will be identified accordingly by being so stamped and dated and returned to the Contractor.
- B. Submittals made by the Contractor that are not required by the Contract Documents or were not otherwise requested shall be designated "No Action Taken."

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 33 00**

## **SECTION 01 35 15**

### **MAINTENANCE AND PROTECTION OF RAILROAD TRAFFIC**

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

##### **1.01 SUMMARY**

This Section sets forth the procedures for Contractor work on or near track and track structures.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 14 00, Work Restrictions
- B. Section 01 14 16, Coordination with SCRRA
- C. Section 01 35 23, Site Safety Requirements

##### **1.03 WORK ON TRACK AND TRACK STRUCTURES**

- A. The Contractor's work on the track structure prior to returning the track to full service, shall be protected by speed restrictions for train traffic consistent with the direction of the Authority, who will interpret the current issue of the SCRRA Track Maintenance Manual, and the Track Safety Standards of the FRA. The Contractor shall comply with the SCRRA interpretation of all requirements relating to work on track and track structures.
  - 1. In order to minimize impacts to the SCRRA quality of passenger service, the Work will be arranged so that there are not more than two locations with speed restrictions due to the Contractor's work at any time on any passenger route, and the cumulative amount of such delay is not to exceed 4 minutes per train at any time for each passenger route. Such speed restrictions are to be computed compared to the speeds contained in the latest effective SCRRA Timetable.
  - 2. If the number of locations with speed restrictions or the amount of delay exceeds these limits, the Authority will prohibit the Contractor from beginning any additional Work. The Contractor will not be entitled to any payment for failure to obtain access to the track for Work on occasions when the Authority denies new Work locations due to excessive speed restrictions at existing Work locations

##### **1.04 WORK ADJACENT TO LIVE TRACK**

- A. Safety and Delay of Trains
  - 1. The Work shall be coordinated so that there will be no delay to trains, or interference in any manner with the operation of trains. If it is deemed not feasible to perform the Work in such a manner, the Contractor shall request approval from Authority of an alternate method before starting the Work.



2. Only as permitted by the Authority's Operating Department will the Authority allow the Contractor to take more than one adjacent mainline or controlled siding track out of service.
- B. The Contractor shall abide by the instructions of the Authority, its authorized inspectors, RWICs, watchmen, and other designated Authority work forces. Returning the track to service after the Contractor's work near an operating railroad track, during construction on an interim basis only, shall be the sole responsibility of the Authority at the end of the work window.
  - C. If damage is sustained by any of the existing or new communications or signal equipment, underground or aboveground, as a result of the Contractor's operations, whether the damage sustained was intentional or not, the Contractor shall be liable for the following incurred costs:
    1. Replacement of the damaged equipment
    2. Any necessary inspection and testing of the system, before and after replacement of the damaged equipment
    3. Any other costs incurred as a direct, or indirect, result of disruption to normal train operations
  - D. If the location of underground signal equipment interferes with the work, refer to Section 01 14 16, Coordination with SCRRA, for coordination requirements.

#### **1.05 WORK WINDOWS**

- A. Refer to Section 01 14 00, Work Restrictions, for designated work windows for each project location.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 35 15**

## SECTION 01 35 23

### SITE SAFETY REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

Work specified in this Section consists of initiating, maintaining, and supervising all safety precautions and programs and assuring a safe Work Site and safe operations around active tracks. The Contractor shall be solely responsible for ensuring that all Work performed under the Contract is performed in strict compliance with all applicable Federal, State, local occupational safety regulations and SCRRRA rules and requirements adopted to protect all operations. This includes the proper manner of protecting the tracks, signals, fiber optic cables, pipe lines, other Property, and tenants or licensees upon, adjacent to, across (under or over), and along SCRRRA and Member Agency Property during the construction or maintenance activities on or adjacent to Railway Property. This Work includes furnishing, operating, maintaining, and utilizing safety equipment and providing protective equipment, safeguards, and safety devices on construction equipment.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 14 00, Work Restrictions
- B. Section 01 14 16, Coordination with SCRRRA
- C. Section 01 43 23, Contractor Qualifications and Requirements
- D. Section 01 35 44, Environmental Safety and Health Program

##### 1.03 REFERENCE STANDARDS & REQUIREMENTS

Comply with the provisions of all local, State, and Federal regulations; with all applicable Specifications, standards, and recommended practices; and with Authority and Authority-adopted policies, procedures and requirements. Where the State and Federal regulations have differing requirements, the Contractor shall comply with that which is more stringent. These requirements include but are not limited to:

- A. CalOSHA: California State Occupational Safety and Health Administration
- B. CPUC: California Public Utilities Commission General Orders
- C. FRA: 49 CFR Part 214
- D. General Code of Operating Rules (GCOR) Committee: GCOR
- E. SCRRRA: Track Maintenance Manual, On-Track Safety Manual for Roadway Workers, Rules and Requirements for Construction on Railway Property (SCRRRA Form No. 37). See SCRRRA website for more information.
- F. California Code of Regulations (CCR) Title 8, and Code of Federal Regulations (CFR), Title 29.

#### 1.04 SUBMITTALS

The Contractor shall submit to the Authority for review and approval the submittals listed below. The Contractor shall obtain SCRRA approval of the following submittals prior to the start of construction, or as specified in a Limited Notice to Proceed:

- A. Site Specific Injury and Illness Prevention Program (IIPP) including a Site Specific Emergency Action Plan, to be revised and resubmitted as conditions warrant. This Program shall include details of procedures, equipment and training in accordance with Cal OSHA requirements including work in confined spaces, lock out/tag out and fall protection procedures to ensure that the Contractor's and sub-Contractor's workers are properly protected. An Environmental Health and Safety Plan per Section 01 35 44 may also be required prior to beginning Work.
- B. Qualifications and certifications of designated lead and other safety representatives, and other first aid providers. This includes the qualifications and certifications of individuals who will serve as qualified or competent persons as defined in CCR Title 8. These supervisory individuals are designated by the Contractor to supervise special high risk/high hazard safety programs such as fall protection, excavation, hazardous substances operations and confined space entry.
- C. Work Plans for all excavation for which a protective system is required by CCR Title 8 Article 6. This includes plans and drawings for any ground support system to be used during the excavation and the slopes and configurations of sloping or benching systems. Any engineered shoring within the railroad load influence zone shall be designed by a Professional Engineer, Structural or Civil, licensed in the State of California.
- D. Material Safety Data Sheets and other records as required by jurisdictional agencies.
- E. Immediate notification to the Authority's Dispatch and Operations Center (DOC) is required for injury to any individual; the Contractor shall submit an injury report to the Authority within 24 hours of said injury.
- F. All cranes and on-track equipment operated on the Project Site by the Contractor and or Sub-Contractors of any tier require annual and four-year certifications. Any crane subjected to upset, overloading, side pulling, shock loading or support failure, shall be re-certified to allow further use.

### 1.05 SAFETY AND HEALTH PERSONNEL

- A. Provide a Safety Representative, as described in Section 01 43 23, Contractor Qualifications and Requirements, who shall coordinate and supervise on-site safety and health, including training and testing the Contractor's personnel so that they may become qualified in Authority Roadway Worker Protection (RWP) requirements. The Contractor shall ensure that only those Safety representative(s) accepted by the Authority for employment on the Site is/are present at the Site whenever work is in progress at the Site. The absence of the required Safety Representative shall result in the immediate stoppage of all work at the Site. In order to avoid Work stoppages in the event of an expected or unexpected absence due to vacation, illness, personal emergency, resignation or termination of the assigned Safety Representative(s), the Contractor shall ensure adequate safety personnel, whose qualifications have been submitted to and approved by the Authority are available. The Safety Representative(s) shall have the Authority to direct immediate correction of any unsafe or unhealthful condition and, as necessary, to stop Work until appropriate corrective measures have been completed, attend required meetings, be fully cognizant of all Project-specific safety practices, processes, rules and procedures, and maintain regular contact with Authority-designated safety personnel.
- B. The Contractor's Safety Representative shall have no other duties unless those duties are specified elsewhere or approved by the Authority. The Safety Representative shall not be utilized in any other Authority Contract or any other project without prior written consent from the Authority.
- C. The Contractor's Safety Representative shall be responsible for overseeing safety procedures for Work performed around active tracks and shall be qualified under the Roadway Worker-In-Charge (RWIC) part of the SCRRRA Roadway Worker Protection training before any Work begins.
- D. At Limited NTP, or the project kick-off meeting, the Authority shall provide contact numbers for all entities to be contacted in case of emergency. This will include the Chief Dispatcher, the Metrolink Sheriff's Dispatcher, signal emergencies and grade crossing problems, and signal and communications cable locations.

### 1.06 ROADWAY WORKERS AND WATCHMEN

- A. Before starting Work on Authority property, all Contractor or Subcontractor personnel working within Authority right of way must be qualified, trained, and currently certified under SCRRRA's Roadway Worker Protection (RWP).
  - 1. Required training and testing of personnel to be qualified under RWP may be conducted by the Authority or by the Contractor's Safety Representative, at the Authority's discretion. All training for Contractor personnel shall be renewed annually.
  - 2. The Contractor shall reproduce, and distribute to each employee during the training session, the SCRRRA *On-Track Safety Manual for Roadway Workers*.

- B. Watchmen, equipped with suitable Authority approved safety equipment, shall be furnished by SCRRA for protection of workers as requested by the RWIC or required in the approved SSWP.

- 1. .

### **1.07 CONSTRUCTION AND SAFETY EQUIPMENT**

- A. The Contractor shall conform to requirements of the Authority, CalOSHA, CPUC, and to applicable codes and regulations of Federal, State, and local authorities having jurisdiction over job-site safety including compliance with the safety standards of the FRA for roadway worker protection per 49 CFR, Part 214, Railroad Workplace Safety. The Contractor shall provide and maintain such lights, protective devices, barricades, Type K railing, changeable message signs (CMS), and warning signs as are necessary for the safety of personnel and the public, or as otherwise required by SCRRA. The Contractor shall be solely responsible for the timely erection, maintenance, repair, replacement, and removal of such safeguards, without necessity of receiving specific instructions from SCRRA, or any other authority having jurisdictional.
- B. As identified in the IIPP, the Contractor shall provide job specific fall protection from hazards such as: skylights (at any angle), floor and wall openings, leading edges, and steel erection. Methods of protection may include: fixed systems (guardrails, covers, nets, etc.) and personal fall arrest systems.
- C. All equipment, tools and or other items used to complete the Work shall be inspected by the Contractor to ensure compliance with applicable regulatory standards. Equipment shall be used in accordance with the respective manufacturer's design, directions, and intended use.

### **1.08 TESTING EQUIPMENT**

Testing equipment, as applicable to Work Site safety, shall conform to the requirements of the California Code of Regulations, Title 8, Division of Industrial Safety, unless indicated otherwise.

### **1.09 IDENTIFICATION OF CONTRACTOR/SUBCONTRACTOR PERSONNEL**

- A. All construction personnel Contractor personnel shall be identified with the employee's company name or logo affixed to the employee's hardhat, identification badge, or other identification acceptable to the Authority. All Contractor personnel shall wear hard hats affixed with the Authority Roadway Worker Protection trained sticker, denoting current certification. Failure to comply will result in revocation of employee's permission to access Work Site.
- B. Contractor personnel shall wear hard hats, orange safety vests or orange T-shirts with reflective strips, safety glasses, and safety shoes at all times while on the Project.

## **1.10 CLEARANCE REQUIREMENTS**

During operations adjacent to live track, all Work within the foul zone of the live track or adjacent track, or as directed by the RWIC must be stopped when trains are approaching and equipment and employees moved to a safe distance from the tracks unless otherwise approved. All Contractor equipment within the Authority Right of Way will stop Work when trains are approaching.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 CONSTRUCTION SUPERVISION AND METHODS**

The Contractor is solely responsible for all construction means, methods, techniques, and procedures and for coordinating all portions of the Work under the Contract. This shall include the following:

- A. The Contractor shall establish, implement and maintain an effective IIPP in accordance with CCR Title 8 Section 3203. Contractor shall at all times conduct its operations in accordance with the IIPP and in such a manner as to avoid risk of bodily harm to persons or damage to property and shall promptly take all reasonable precautions to safeguard against such risks and shall make regular safety inspections of its operations. Contractor shall be solely responsible for the discovery, determination and correction of any unsafe conditions related to Contractor's performance of the Work.
- B. The Contractor shall secure all Work areas by barricade in accordance with local and State requirements as applicable at the end of each day. All excavations shall be covered to prevent tripping hazard.
- C. In the event the Authority discovers that the Contractor has created an unsafe condition or has failed to restore the track to service at the specified time, the Authority with its own forces may perform the remedial Work to secure the required safety and train performance. Such remedial Work will be at the sole discretion of the Authority; however, Contractor may perform such Work if agreed to by Authority. If this action is required, the Authority may unilaterally terminate Work under the Contract, and will pay only for the quantities of Work actually performed, less the cost of Authority's remedial Work. In the event Work is halted under this circumstance, the Mobilization line item will not be paid. In the event that Work is not halted, the Contractor must take immediate steps to correct the situation. There will be no extra payment for Work required to correct unsafe conditions or to promptly restore track to service. For purposes of this Section, an unsafe condition is defined as creating a track condition which does not meet the FRA Track Safety Standards for Class of Track, willful damage to facilities or material, or any other unsafe condition for trains, employees, passengers or the public, at the sole determination of the Authority.

- D. Prior to operating cranes on the Site, all crane operators shall have successfully completed testing that verifies the crane operator's ability to read and understand the load chart for the equipment to be operated. This testing may be performed by an independent certifying agency or a qualified member of the Contractor's supervisory staff who is acceptable to the Authority, has a minimum of five years heavy civil construction experience, and can satisfactorily demonstrate the ability to read and understand load charts and rigging tables to the Authority when requested, without prior notice. Written records of this testing shall be maintained on the Site and made available to the Authority for review without prior notice. Re-certification is required for any crane involved in an incident involving upset, overloading, side pulling, shock loading, or support failure. Re-certification and written acceptance by the manufacturer is also required for any modification to a crane. All crane operators shall be licensed by the Authority having jurisdiction for the equipment type to be operated and copies of said licenses shall be submitted to the Authority. All crane operations where the load is beyond the direct view of the operator shall be observed by a signal person who can directly observe the load and be observed by the operator. The Contractor shall stop load movement in the event the signal Person is unable to observe the load or fails to continuously observe the load and signal the operator.
- E. All excavation operations shall be under the immediate supervision of a competent person, as defined in CCR Title 8, who is fully familiar with the requirements for safe excavation procedures and capable of enforcing strict compliance with the ground support system plan.
- F. If required by regulation, the Contractor shall provide air monitoring including operating and maintaining a gas monitoring system with equipment capable of providing printed logs of gas tests. Begin testing for toxic and explosive gases as soon as the excavation or drilled hole has progressed to a level of five feet below surface level. Test air quality in the most stagnant portions of excavation to ensure there is no accumulation of explosive or other dangerous gases. The Contractor shall provide training to construction personnel, subject to exposure during the course of excavation, prior to entering any excavation sites and provide necessary yearly refresher training.

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 35 23**

## **SECTION 01 35 44**

### **ENVIRONMENTAL SAFETY AND HEALTH PROGRAM**

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

##### **1.01 SUMMARY**

Contaminated and Hazardous Soils may be encountered during the Work. The Contractor shall be solely responsible for ensuring that all Work performed when these Soils are present complies with all applicable Federal, State, local occupational safety regulations and SCRRA rules and requirements. In order to properly handle these types of soil, the Contractor shall prepare and implement an Environmental Safety and Health Program and require that all its Subcontractors perform excavation and handling of soils in full compliance with the requirements of the Environmental Safety and Health Program.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 14 00, Work Restrictions
- B. Section 01 35 23, SCRRA Site Safety Requirements
- C. California Code of Regulations (CCR) Titles 4, 8, & 22, the Code of Federal Regulations (CRF) Title 29 and all applicable Code of Federal Regulations Titles.
- D. CalOSHA: California State Occupational Safety and Health Administration
- E. OSHA: Federal Occupational Safety and Health Administration
- F. Section 31 20 50, Removal and Disposal of Contaminated Soils

##### **1.03 PROCEDURE**

If the Contractor encounters substances during performance of the Work that are reasonably believed to be potentially chemically-impacted as defined in Section 31 20 50, the Contractor shall notify the Authority immediately, submitting written documentation of the incident and notification within 24 hours. Contractor will proceed with work in accordance with Section 31 20 50, Removal and Disposal of Contaminated Soils. Excavation in the immediate area of the potentially chemically-impacted soil shall be suspended, and work shifted to another location until authorization to resume is received. Equitable adjustments, if any, for time lost or costs incurred due to the inability to relocate the work as a result of such encounters will be made in accordance with Contract Change Order Procedures. The Authority reserves the right to use other labor forces for exploratory work to determine the nature and extent of the potentially chemically-impacted soil and to remove the substances from the area.



For chemically-impacted and hazardous waste soils as defined in Section 31 20 50, Authority's involvement will be limited to coordination with regulatory agencies, sampling oversight, and ensuring proper disposal of the chemically-impacted and/or hazardous waste soil. The Contractor shall be responsible for sampling and proper disposal of the chemically-impacted and/or hazardous waste soil by loading, unloading, and transporting to a designated site for testing and to a stockpile with proper protection as described in Section 31 20 50. The Contractor shall also be responsible for loading chemically-impacted and/or hazardous waste soils for hauling off, with oversight by the Authority. All import and backfill with suitable material shall be done by the Contractor to restore the site as directed by the Authority.

For lead-containing materials, the Contractor shall submit a Work plan to the Authority for review and approval prior to any demolition work. All Work shall be done in full compliance with requirements of the California Code of Regulations, Title 8 specifically Section 5192, Hazardous Waste Operations and Emergency Response (HAZWOPER).

Existing wood railroad-tie materials, where designated to be demolished/removed shall be considered hazardous treated wood waste and should be managed and disposed of in accordance with CCR Title 22, Division 4.5, Chapter 34, Section 67386.

#### **1.04 SUBMITTALS**

- A. An effectively written and coherent Site-Specific Safety and Health Plan, as defined in CCR Title 8, prior to the start of construction, or as specified in the Limited Notice to Proceed.
- B. Certificates of training for personnel potentially working with chemically-impacted and/or hazardous waste soil: minimum initial 40-hour HAZWOPER training and 8-hour annual refresher, respiratory protection, and fit-testing, and medical clearance, before start-up of excavation and drilling activities if required.
- C. Certificates of training for the Site Safety and Health Officer: minimum initial 40-hour HAZWOPER training, 8-hour annual refresher, 8-hour Site Supervisor training, respiratory protection and fit-testing, medical clearance, experience, and credentials.
- D. Monthly status report of chemically-impacted and/or hazardous waste soil management, including excavated quantities of each soil category and work performed using Personal Protective Equipment (PPE). This report must include updated quantities of excavated chemically-impacted and/or hazardous waste soils, and the date, time, number of affected workers, and total number of hours the Contractor performed work in Level C Protection.
- E. The Work Plan for removal of lead-containing material shall include the following:
  - 1. A state lead-licensed Contractor and persons shall perform demolition, handling, removal, and monitoring of lead-contained materials.
  - 2. Air monitoring shall be performed before and during each lead-related activity. The Contractor performing demolition work shall not conduct monitoring work, during or after the completion of all lead-related activities.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

PPE and monitoring equipment shall conform to requirements set forth by CAL/OSHA, Federal-OSHA, and the Contractor's Environmental Safety and Health Program.

### **2.02 HEPA FILTERS**

Contractor shall provide high-efficiency particulate air (HEPA) filters for persons working on lead-containing materials.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Implement an Environmental Safety and Health Plan for removal of lead-containing material, and excavation and handling of chemically-impacted and/or hazardous waste soil (aka California Hazardous Soils) certified by a Certified Industrial Hygienist (CIH) licensed by the American Board of Industrial Hygiene.
- B. The Contractor will be responsible for performing soil monitoring and sampling for disposal purposes, with oversight by the Authority, as specified in Section 31 20 50. The Contractor shall be responsible for loading, unloading, and transporting all soils to the designated area. The contaminated and clean soils shall be stored in separated piles. The designated area shall be protected with visqueen sheets covering the ground and fenced off to prevent trespassing. The soils shall be covered with visqueen sheets prior to legally disposing of them from the site. The Contractor will be responsible for analyzing soil, as well as for trucking and disposing of the contaminated soil accordingly. The Contractor shall be responsible for loading contaminated soil into trucks furnished by the Contractor.
- C. Designate a full-time Site Safety and Health Officer to recognize hazards and implement and manage the Environmental Safety and Health Program. The Safety and Health Officer can be a Safety Engineer, provided the individual is qualified to conduct air monitoring and identify environmental hazards, and meets all training requirements set forth in 8 CCR 5192 (e), in addition to the qualifications set forth in the Construction Safety and Security Manual. As a minimum, the Safety and Health Officer shall (a) monitor air quality and hazards to personnel and the Work area during removal of lead-containing material and excavation and handling of chemically-impacted and/or hazardous waste soil and groundwater, and (b) assign PPE and other equipment necessary for the implementation of the Safety and Health Program.
- D. Supply a direct reading Organic Volatile Analyzer equipped with a Photo-ionization Detector (PID) and an initial supply of PPE readily available for use by the team. Replenish the PPE to ensure a supply of PPE is always available to prevent any delays.
- E. Supply high efficiency particulate air (HEPA) filters for persons working on removal of lead-containing materials.

- F. The Contractor is responsible for any delays associated with lack of preparation, PPE, trained and qualified personnel.

### 3.02 PERFORMANCE

- A. Provide, without delay to Work, HAZWOPER-trained, medically qualified, and respirator-fitted workers, and PPE and other equipment, as necessary for implementation and maintenance of the Environmental Safety and Health Program.
- B. The Contractor will be responsible for performing soil monitoring and sampling for disposal purposes, with oversight from the Authority, as specified in Section 31 20 50. If the sampled soil is found to be clean, the Contractor shall dispose of it in the same manner and location as used for other clean soil removed from the site. The Contractor shall be responsible for loading, unloading, and transporting all soils to the designated area. The contaminated and cleans soils shall be stored in separate piles. The designated area shall be protected with visqueen sheets covering the ground, and fenced off to prevent trespassing. The soils shall be covered with visqueen sheets prior to legally disposing of them from the site. The Contractor will be responsible for analyzing the soil, as well as for trucking and disposing of the contaminated soil accordingly. The Contractors shall be responsible for loading contaminated soil into trucks furnished by the Contractor.
- C. In the event the Contractor encounters or suspects potentially chemically-impacted soil, Contractor shall promptly implement measures described in the Contractor Site-Specific Safety and Health Plan, and immediately notify the Authority or its designee.
- D. Ventilation shall be modified, if necessary or if directed by the Authority, to increase airflow and effectively reduce air contaminants prior to and during removal of lead-containing materials, excavation, and handling of chemically-impacted and/or hazardous waste soil. If Excluded Hazardous Waste Operations are required, the Contractor shall adequately protect the safety and health of its employees, and Subcontractors' employees while working in areas not affected.
- E. The Contractor shall be responsible for legal removal of lead-containing materials. The Contractor shall employ a state lead-licensed Contractor for performing such work including demolition, handling, removal, and monitoring of lead-contained materials. All work shall be done in full compliance with requirements of the California Code of Regulations, Title 8, Sections 1532.1 and 5198.
- F. The wet method for removal of lead-contained materials shall be used to prevent dust. Lead dust shall be properly disposed of. Air monitoring shall be performed before, during, and after each lead-related activity. A third party without conflict of interest with the Contractor shall conduct the air and clearance monitoring. Surface clearance monitoring shall be conducted after completion of the removal of lead materials. The purpose of the air monitoring is to ascertain that the building air quality is maintained during and after the completion of the Project. All air monitoring results shall be submitted to the Authority's Corporate Safety representative for review within 24 hours of receipt from the laboratory.

- G. The Contractor is responsible for the safety and health of its employees and its Subcontractors. The Contractor shall conduct air monitoring to ensure compliance with monitoring requirements under the Environmental Safety and Health Program, the Site-Specific Safety and Health Plan, CAL/OSHA, and any other local, state, or federal requirements.
- H. Dust control and suppression mitigation measures shall be employed by the Contractor. The Authority reserves the right to conduct air sampling and monitoring to determine the required minimum level of protection.

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 35 44**

## SECTION 01 35 91

### HISTORIC TREATMENT PROCEDURES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes general protection and treatment procedures for designated historic spaces, areas, rooms, and surfaces in the Project and the following specific work:

- A. Historic removal and dismantling
- B. Bird-excrement removal

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 35 23, Site Safety and Health Program
- B. Section 01 35 44, Environmental Safety and Health Program
- C. Section 01 74 19, Construction Waste Management and Disposal

##### 1.03 DEFINITIONS

- A. "Preservation": To apply measures necessary to sustain the existing form, integrity, and materials of a historic property. Work may include preliminary measures to protect and stabilize the property.
- B. "Rehabilitation": To make possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features that convey its historical, cultural, or architectural values.
- C. "Restoration": To accurately depict the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and the reconstruction of missing features from the restoration period.
- D. "Reconstruction": To reproduce in the exact form and detail a structure or artifact as it appeared at a specific period in time.
- E. Consolidate: To strengthen loose or deteriorated materials in place.
- F. Dismantle: To disassemble and detach items by hand from existing construction to the limits indicated, using small hand tools and small one-hand power tools, so as to protect nearby historic surfaces; and legally dispose of dismantled items off-site, unless indicated to be salvaged or reinstalled.
- G. Existing to Remain: Existing items that are not to be removed or dismantled.

- H. Historic: Spaces, areas, rooms, surfaces, materials, finishes, and overall appearances that are important to the successful preservation, rehabilitation, restoration, and reconstruction as determined by the Authority. Designated historic spaces, areas, rooms, and surfaces are indicated on the Contract Documents and generally described below.
1. Restoration Zones: Areas of greatest architectural importance, integrity, and visibility; these areas are to be preserved and restored to the original, design and finish as shown on Contract Documents.
  2. Renovation Zones: Areas of significant architectural importance, integrity, and visibility; these areas are to be preserved and restored consistent with the remaining historic fabric and to the extent shown on Contract Documents.
  3. Alteration Zones: Areas of slight architectural importance, integrity, and visibility; goal is to leave any remaining original fabric untouched insofar as is consistent with accommodating modern uses for the structure as shown on Contract Documents.
- I. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish as approved by the Authority.
- J. Reconstruct: To remove existing item, replicate damaged or missing components, and reinstall in original position.
- K. Refinish: To remove existing finishes to base material and apply a new finish to match the original, or as otherwise indicated.
- L. Reinstall: To protect a removed or dismantled item, repair and clean it as indicated for reuse, and reinstall it in original position, or where indicated.
- M. Remove: Specifically for historic spaces, areas, rooms, and surfaces, the term means to detach an item from existing construction to the limits indicated, using hand tools and hand-operated power equipment, and legally dispose of it off-site, unless indicated to be salvaged or reinstalled.
- N. Repair: To correct damage and defects, retaining existing materials, features, and finishes while employing as little new material as possible. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- O. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- P. Replicate: To reproduce in exact detail, materials, and finish, unless otherwise indicated.
- Q. Reproduce: To fabricate a new item, accurate in detail to the original, and in either the same or a similar material as the original, unless otherwise indicated.
- R. Restore: To consolidate, replicate, reproduce, repair, and refinish as required to achieve the indicated results.

- S. Retain: To keep existing items that are not to be removed or dismantled.
- T. Reversible: New construction work, treatments, or processes that can be removed or undone in the future without damaging historic materials, unless otherwise indicated.
- U. Salvage: To protect removed or dismantled items and deliver them to the Authority ready for reuse.
- V. Stabilize: To provide structural reinforcement of unsafe or deteriorated items while maintaining the essential form as it exists at present; also, to reestablish a weather-resistant enclosure.
- W. Strip: To remove the existing finish down to base material, unless otherwise indicated.

#### **1.04 MATERIALS OWNERSHIP**

- A. Historic items, relics, and similar objects—including but not limited to cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to the Authority that may be encountered during removal and dismantling work—remain the Authority's property. Carefully dismantle and salvage each item or object.
- B. Coordinate with the Authority's archaeologist or historical adviser, who will establish special procedures for dismantling and salvage.

#### **1.05 SUBMITTALS**

- A. Construction Schedule for Historic Treatments: Indicate for the entire Project the following for each activity to be performed in historic spaces, areas, and rooms, and on historic surfaces:
  - 1. A detailed sequence of historic treatment work, with starting and ending dates, coordinated with the Authority's continuing operations and other known work in progress.
  - 2. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
  - 3. Coordination of Authority's and others' continuing occupancy of portions of the existing structure and of the Authority's partial occupancy of completed Work.
  - 4. Equipment Data: List gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use. Do not use such equipment without the Contractor's professional engineer's certification that the structure can support the imposed loadings without damage.
- B. Qualification Data: For historic removal and dismantling, provide a bird-excrement-removal specialist and an industrial hygienist.

- C. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by historic treatment operations.
- D. Historic Treatment Program: Submit before Work begins.
- E. Fire-Prevention Plan: Submit before Work begins.
- F. Inventory of Salvaged Items: After removal or dismantling work is complete, submit a list of items that have been salvaged.

## 1.06 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: This term describes an experienced firm or group of individuals regularly engaged in historic treatments similar in nature, materials, design, and extent to this work as specified in each Section, and that has completed a minimum of four recent projects with a record of successful in-service performance that demonstrate the firm's qualifications to perform this Work.
  - 1. Field Supervisor Qualifications: Full-time supervisors experienced in historic treatment work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on the Project site when historic treatment work is in progress. Supervisors shall not be changed during the Project, except for causes beyond the control of the specialist firm.
  - 2. Worker Qualification: Persons who are experienced in historic treatment work of the types they will be performing.
- B. Historic Removal and Dismantling Specialist Qualifications: A qualified historic treatment specialist. General selective demolition experience is not sufficient experience for historic removal and dismantling work.
- C. Bird-Excrement-Removal Specialist Qualifications: A firm or group of individuals experienced and skilled in the processes and operations indicated.
- D. Industrial Hygienist Qualifications: Certified as Industrial Hygienist by the American Board of Industrial Hygiene; having a bachelor's degree in industrial hygiene, public health, biological science, occupational health, or environmental and safety discipline; and experienced in work of the types specified.
- E. Historic Treatment Program: Prepare a written plan for historic treatment for the whole Project, including each phase or process and protection of surrounding materials during operations. Describe in detail materials, methods, and equipment to be used for each phase of Work. Show compliance with indicated methods and procedures specified in this and other Sections.
  - 1. Dust and Noise Control: Include the locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known Work in progress.



2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
- F. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-prevention devices during each phase or process. Coordinate the plan with the Authority's fire-protection equipment and requirements. Include each fire watch's training, duties, and Authority to enforce fire safety.
- G. Mockups: Prepare mockups of specific historic treatment procedures specified in this Section to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Typical Removal Work: Remove an approximately 50–square foot area of typical wall, ceiling, floor or deck, or paving, but not less than 10 adjacent whole masonry, stone, ceiling tile units.
  2. Typical Dismantling Work: Dismantle an approximately 50–square foot area of typical substrate, but not less than 10 adjacent whole masonry, stone or ceiling units.
  3. Bird-Excrement Removal: Remove excrement from an area approximately 25 square feet for each type of structure cornice, coping, wall, or other substrate material.
    - a. Test chemicals and methods on samples of adjacent structure materials for possible adverse reactions. Do not use chemicals and methods known to have a deleterious effect.
    - b. Allow a waiting period of not less than seven days after completion of removal work to permit a study of mockup for deleterious effects.
  4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the Authority specifically approves such deviations in writing.
- H. Regulatory Requirements: Comply with governing EPA notification regulations before beginning removal and dismantling Work. Comply with hauling and disposal regulations of authorities having jurisdiction.
- I. Standards: Comply with ANSI/ASSE A10.6.
- J. Historic Treatment Preconstruction Conference: Conduct the conference at the Project site.
1. General: Review methods and procedures related to historic treatment including, but not limited to, the following:
    - a. Review manufacturer's written instructions for precautions and effects of historic treatment procedures on materials, components, and vegetation.

- b. Review and finalize historic treatment construction schedule; verify availability of materials, equipment, and facilities needed to make progress and avoid delays.
  - c. Review qualifications of personnel assigned to the work and assign duties.
  - d. Review material application, work sequencing, tolerances, and required clearances.
  - e. Review areas where existing construction is to remain and requires protection.
2. Removal and Dismantling:
    - a. Inspect and discuss the condition of construction to be removed or dismantled.
    - b. Review requirements of other Work that relies on substrates exposed by removal and dismantling work.

#### **1.07 STORAGE AND PROTECTION OF HISTORIC MATERIALS**

- A. Salvaged Historic Materials:
  1. Clean only loose debris from salvaged historic items unless more extensive cleaning is indicated.
  2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
  3. Store items in a secure area until delivery to the Authority.
  4. Transport items to the Authority's storage area off-site designated by the Authority.
  5. Protect items from damage during transport and storage.
- B. Historic Materials for Reinstallation:
  1. Repair and clean historic items as indicated and to functional condition for reuse.
  2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
  3. Protect items from damage during transport and storage.
  4. Reinstall items in the locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make item functional for use indicated.

- C. Existing Historic Materials to Remain: Protect construction indicated to remain against damage and soiling from construction Work. Where permitted by the Authority, items may be dismantled and taken to a suitable, protected storage location during construction Work and reinstalled in their original locations after historic treatment and construction Work in the vicinity is complete.
- D. Storage and Protection: When taken from their existing locations, catalog and store historic items within a weather-tight enclosure where they are protected from wetting by rain, snow, condensation, or ground water, and from freezing temperatures.
  - 1. Identify each item with a nonpermanent mark to document its original location. Indicate original locations on plans elevations, sections, or photographs by annotating the identifying marks.
  - 2. Secure stored materials to protect from theft.

### 1.08 PROJECT CONDITIONS

- A. General Size Limitation in Historic Spaces: Materials, products, and equipment used for performing the Work and for transporting debris, materials, and products shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.
- B. The Authority will occupy portions of a structure immediately adjacent to the removal and dismantling area. Conduct removal and dismantling work so the Authority's operations will not be disrupted.
- C. Conditions existing at the time of inspection for bidding purposes will be maintained by the Authority as far as practical, unless otherwise indicated in the Contract Documents.
- D. Notify the Authority of discrepancies between existing conditions and the Contract Documents before proceeding with removal and dismantling Work.
- E. Exterior Cleaning and Repairing:
  - 1. Proceed with the Work only when forecasted weather conditions are favorable.
    - a. Wet Weather: Do not attempt repairs during rainy or foggy weather. Do not apply primer, paint, putty, or epoxy when the relative humidity is above 80 percent. Do not remove exterior elements of structures when rain is forecast or in progress.
    - b. Do not perform exterior wet work when the air temperature is below 40 F.
    - c. Do not begin cleaning, patching, or repairing when there is any likelihood of frost or freezing.

- d. Do not begin cleaning when either the air or the surface temperature is below 45 F unless approved means are provided for maintaining a 45 F temperature of the air and materials during, and for 48 hours subsequent to, cleaning.
  2. Perform cleaning and rinsing of the exterior only during daylight hours.
- F. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
1. Hazardous materials will be removed by the Authority before the start of the Work.
  2. If materials suspected of containing hazardous materials are encountered, do not disturb them; immediately notify the Authority and the Authority. The Authority will remove hazardous materials under a separate contract.
  3. If asbestos is encountered, stop Work in the area of the potential hazard, shut off fans and other air handlers ventilating the area, and rope off the area until the questionable material is identified. Reassign workers to continue Work in unaffected areas. Resume Work in the area of concern after safe working conditions are verified.
- G. Storage or sale of removed or dismantled items on-site is not permitted unless otherwise indicated.

## **1.09 COORDINATION**

Coordinate historic treatment procedures in this Section with public circulation patterns at the Project site. Some Work is near public circulation patterns and active railroad tracks. Public circulation patterns cannot be closed off entirely, and in places can be only temporarily redirected around small areas of Work. Railroad traffic will not be stopped. Plan and execute the Work accordingly.

## **PART 2 - PRODUCTS - (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 NOTIFICATION**

All things of historical, archaeological, paleontological, or scientific interest encountered by the Contractor during progress of the Work shall be reported immediately to the Authority. Construction in the vicinity of the discovery shall be halted in order to preserve and protect it until its significance can be determined by the Authority. The Authority will issue instructions to the Contractor with respect to the disposition of the discovery.

### **3.02 HISTORIC REMOVAL AND DISMANTLING EQUIPMENT**

- A. Removal Equipment: Use only hand-held tools except as follows or unless otherwise approved by the Authority on a case-by-case basis:
1. Light jackhammers are allowed, subject to the Authority's approval.

2. Large air hammers are not permitted.
- B. Dismantling Equipment: Use manual, hand-held tools, except as follows or otherwise approved by the Authority on a case-by-case basis:
1. Hand-held power tools and cutting torches are permitted only as submitted in the historic treatment program. They must be adjustable so as to penetrate or cut only the thickness of material being removed.
  2. Pry bars over 18 inches long and hammers weighing over 2 pounds are not permitted for dismantling Work.

### 3.03 EXAMINATION

- A. Preparation for Removal and Dismantling: Contractor shall examine construction to be removed or dismantled to determine the best methods for safely and effectively performing removal and dismantling Work. Examine adjacent Work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine the condition of construction to be removed or dismantled, and the location of utilities and services to remain that may be hidden by construction that is to be removed or dismantled.
1. Verify that affected utilities have been disconnected and capped.
  2. Inventory and record the condition of items to be removed and dismantled for reinstallation or salvage.
  3. Before removal or dismantling of existing structure elements that will be reproduced or duplicated in final Work, make a permanent record of measurements, materials, and construction details required to make exact reproduction.
  4. Engage a professional engineer to survey the condition of the structure to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures as a result of removal and dismantling Work.
- B. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs, and preconstruction videotapes as appropriate and approved by the Authority. Comply with requirements specified in Section 01 32 33, Photographic Documentation.
- C. Perform surveys as the Work progresses to detect hazards resulting from historic treatment procedures.

### 3.04 PROTECTION, GENERAL

- A. Ensure that supervisory personnel are on site and on duty when historic treatment Work begins and during its progress.
- B. Protect persons, motor vehicles, surrounding surfaces of the structure, the structure site, plants, and surrounding structures from harm resulting from historic treatment procedures.

1. Use only proven protection methods, appropriate to each area and surface being protected.
  2. Provide barricades, barriers, and temporary directional signage to exclude the public from areas where historic treatment Work is being performed.
  3. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during the course of historic treatment Work.
  4. Contain dust and debris generated by removal and dismantling work and prevent it from reaching the public or adjacent surfaces.
  5. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
  6. Protect floors, paving, and other surfaces along haul routes from damage, wear, and staining.
  7. Provide supplemental sound-control treatment to isolate removal and dismantling Work from other areas of the structure and site.
- C. Temporary Protection of Historic Materials:
1. Protect existing historic materials with temporary protections and construction. Do not deface or remove existing materials.
  2. Do not attach temporary protection to historic surfaces except as indicated as part of the historic treatment program and approved by the Authority.
- D. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- E. Utility and Communications Services:
1. Notify the Authority and other authorities having jurisdiction, owning or controlling wires, conduits, pipes, and other services affected by the historic treatment Work before commencing operations.
  2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for the historic treatment Work.
  3. Maintain existing services unless otherwise indicated; keep them in service and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- F. Existing Drains: Prior to the start of Work in an area, test the drainage system to ensure that it is functioning properly. Notify the Authority immediately of inadequate drainage or blockage. Do not begin Work in an area until the drainage system is in working order.

1. Prevent solids such as stone or mortar residue from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from historic treatment work.
  2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
- G. Existing Roofing: Prior to the start of Work in an area, install roofing protection where indicated on the Contract Documents.

### **3.05 PROTECTION DURING APPLICATION OF CHEMICALS**

- A. Protect motor vehicles, surrounding surfaces of structure being restored, structure site, plants, and surrounding structures from harm or damage resulting from applications of chemical cleaners and paint removers.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for the Project unless chemicals being used will not damage adjacent surfaces, as indicated in the historic treatment program. Use covering materials and masking agents that are waterproof and UV-resistant, and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to the manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials staining.
- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize and collect alkaline and acid wastes and legally dispose of them off of the Authority's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into structure interior.

### **3.06 PROTECTION FROM FIRE**

- A. General: Follow the fire-prevention plan and the following:
1. Remove and keep the area free of combustibles, including, rubbish, paper, waste, and chemicals, except to the degree necessary for the immediate Work.
  2. If combustible material cannot be removed, provide fire blankets to cover such materials.
  3. Prohibit smoking by all persons within the Project Work and staging areas.
- B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing Work with heat-generating equipment or highly combustible materials, including welding, torch-cutting, soldering, brazing, paint removal with heat, or other operations where open flames or implements utilizing high heat or combustible solvents and chemicals are anticipated.

1. Obtain the Authority's approval for operations involving use of open flame or welding or other high-heat equipment. Notify the Authority at least 72 hours before each occurrence, indicating the location of such Work.
  2. As far as practical, restrict heat-generating equipment to shop areas or outside the structure.
  3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
  4. Use fireproof baffles to prevent flames, sparks, hot gasses, or other high-temperature material from reaching surrounding combustible material.
  5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
  6. Fire Watch: Before working with heat-generating equipment or highly combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire watch personnel shall have the Authority to enforce fire safety.
    - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
    - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
    - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
    - d. Have fire watch perform final fire-safety inspections each day, beginning no sooner than 30 minutes after conclusion of work at the Project site to detect hidden or smoldering fires and to ensure that proper fire-prevention is maintained.
- C. Fire Extinguishers, Fire Blankets, and Rag Buckets: Maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire watch are trained in fire-extinguisher and blanket operation.

### **3.07 GENERAL HISTORIC TREATMENT**

- A. Ensure that supervisory personnel are present when historic treatment work begins and during its progress.
- B. Halt the process of deterioration and stabilize conditions, unless otherwise indicated. Perform work as indicated on Contract Documents. Follow the procedures in subparagraphs below and procedures approved in historic treatment program.



1. Retain as much existing material as possible; when circumstances allow, repair and consolidate rather than replace.
  2. Use additional material or structure to reinforce, strengthen, prop, tie, and support existing material or structures.
  3. Use reversible processes wherever possible.
  4. Use historically accurate repair and replacement materials and techniques unless otherwise indicated.
  5. Record existing work before each procedure (preconstruction) and progress during the work with digital preconstruction documentation photographs or videos. Comply with requirements in the Specifications Section 01 32 33, Photographic Documentation.
- C. Notify the Authority of visible changes in the integrity of material or components, whether due to environmental causes (including biological attack, UV degradation, freezing, or thawing), or due to structural defects (including cracks, movement, or distortion). Do not proceed with the work in question until so directed by the Authority.
- D. Where missing features are indicated to be repaired or replaced, provide features whose designs are based on accurate duplications rather than on conjectural designs, subject to the approval of the Authority.
- E. Where Work requires existing features to be removed or dismantled and reinstalled, perform these operations without damage to the material itself, to adjacent materials, or to the substrate.
- F. Identify new and replacement materials and features with permanent marks hidden in the completed work to distinguish them from original materials. Record a legend of identification marks and the locations of the items on Record Drawings.

### **3.08 HISTORIC REMOVAL AND DISMANTLING**

- A. General: Have removal and dismantling work performed by a qualified historic removal and dismantling specialist. Ensure that the historic removal and dismantling specialist's field supervisors are present when removal and dismantling work begins and during its progress.
- B. Perform work in accordance with the historic treatment program and approved mockups.
1. Provide supports or reinforcement for existing construction that becomes temporarily weakened by the work, until the work is completed.
  2. Perform cutting by hand or with small power tools wherever possible. Cut holes and slots neatly to size required, with minimum disturbance of adjacent work.
  3. Do not operate air compressors inside structure, unless approved by Authority in each case.

4. Do not drill or cut columns, beams, joints, girders, structural slabs, or other structural supporting elements, without having the Contractor's professional engineer's written approval for each location before such work is begun.
  5. Do not use explosives.
- C. Unacceptable Equipment: Keep equipment that is not permitted for historic removal or dismantling work away from the vicinity where such work is being performed.
- D. Removing and Dismantling Items On or Near Historic Surfaces:
1. Use only dismantling tools and procedures within 12 inches of the historic surface. Do not use pry bars. Protect the historic surface from contact with or damage by tools.
  2. Unfasten items to be removed, in the opposite order from which they were installed.
  3. Support each item as it becomes loosened to prevent stress and damage to the historic surface.
  4. Dismantle anchorages.

### **3.09 BIRD-EXCREMENT REMOVAL**

- A. General: Before disturbing accumulated bird excrement, employ a qualified industrial hygienist to oversee the work. Follow procedures required by authorities having jurisdiction and recommended by industrial hygienist.
- B. Removing Bird Excrement: Have bird-excrement removal work performed by a qualified bird-excrement removal specialist. When removing exterior bird-excrement accumulations, ensure structure windows and other openings in the structure are closed or sealed off. Remove interior bird excrement with other parts of the structure sealed off from the work area, and with windows and other openings to exterior areas that are accessible to the public closed or sealed off.
1. Before removal, treat bird excrement to kill pathogens; dampen excrement to prevent particles becoming airborne.
  2. Use only nonmetallic tools such as plastic spatulas and brushes with natural fiber or nylon bristles.
  3. Collect excrement debris as it is removed and legally dispose of it off-site.
  4. Repeat the removal procedure above where required to produce the cleaning effect established by the mockup.
- C. Removing Bird-Excrement Stain: Clean as required in the Section pertaining to cleaning substrate material from which bird excrement was removed.

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 35 91**

## SECTION 01 40 00

### QUALITY REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with specified or indicated Work requirements. These services do not relieve the Contractor of responsibility for compliance with Contract Documents requirements.
- C. Specific tests and inspection requirements are not specified in this Section but rather indicated or included elsewhere in the Contract Drawings (Plans) and Specifications.

##### 1.02 RELATED REQUIREMENTS

- A. Specific quality assurance and quality control requirements for individual construction activities are specified in the Specifications Sections that specify those activities and may also cover production of standard products.
- B. Requirements for the Contractor to provide quality assurance and quality control services required by the Authority, or authorities having jurisdiction, are not limited by provisions of this Section.
- C. Specified tests, inspections and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Documents requirements.

##### 1.03 DEFINITIONS

- A. **Quality Assurance:** Activities, actions, and procedures performed prior to and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with the Contract Documents' requirements.
- B. **Quality Control Services:** Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and that completed construction comply with the Contract Documents' requirements. Services do not include contract enforcement activities performed by the Authority.

- C. Mockups: Full-size, physical assemblies constructed on-site to verify selections made under submittals, to demonstrate aesthetic effects and, the expected qualities of products and materials, and to review details of construction, coordination, testing, or operation; mockups are not Samples. Approved mockups establish the standard by which the Work will be judged.
- D. Preconstruction Testing: Tests and inspections that are performed specifically for the Project, before products and materials are incorporated into the Work in order to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by a Nationally Recognized Testing Laboratory (NRTL), a National Voluntary Laboratory Accreditation Program (NVLAP), or other testing agency qualified to conduct product testing and acceptable to the Authority and all other authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality Control Testing: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- G. Field Quality Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. "Testing laboratory" shall mean the same as testing agency.
- I. Installer/Applicator/Erector: The Contractor or another entity engaged by the Contractor as an employee, or Subcontractor, to perform a particular construction operation, including installation, erection, application, or similar operations.
  - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by an accredited or unionized individual, or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity of individual, 'experienced' means having successfully completed a minimum of five previous projects similar in nature, size, and extent of the Work; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

#### **1.04 CONFLICTING REQUIREMENTS**

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. The Contractor shall refer conflicting requirements to the Authority for a decision before proceeding.

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed by the Contractor. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. The Contractor shall refer uncertainties to the Authority for a decision before proceeding.
- C. Items indicated on the Contract Drawings (Plans) but not included in the Specifications, or included in the Specifications but not indicated on the Plans, shall have the same effect as if indicated or included in both the Plans and Specifications.
- D. In case of conflict or inconsistency between the Plans and Specifications, Contractor shall request additional information or interpretation; any adjustment by Contractor without such official determination shall be at Contractor's own risk and expense.

### **1.05 REGULATORY REQUIREMENTS**

- A. Comply with all applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and Municipal authorities having jurisdiction, and obtain necessary approvals from all such authorities.

### **1.06 ACTION SUBMITTALS**

- A. Shop Drawings

### **1.07 INFORMATIONAL SUBMITTALS**

- A. Contractor Quality Control (CQC) Plan: Submit a formal plan detailing Contractor's quality assurance and quality control activities and responsibilities. Submit in a format acceptable to the Authority. The CQC Plan is due within 15 calendar days following receipt of Award.
  - 1. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out the Contractor's quality control responsibilities.
  - 2. Coordinate this Contractor's Quality control (CQC) Plan with the Contractor's construction schedule.
  - 3. Engage qualified full-time personnel adequately trained and experienced in managing and executing construction quality control procedures similar in nature and extent to those required for this Project.
    - a. Contractor's assigned project quality control manager may not serve as project superintendent, project manager, project engineer, or any other supervisory duties related to production.

4. Include a comprehensive listing of Work which delineates required tests and inspections and Contractor-elected tests and inspections, including (a) Contractor-performed tests and inspections, as well as Subcontractor-performed tests and inspections, (b) and tests and inspections required to be performed by the Authority.
5. Describe procedures for ensuring compliance with the Contract Documents requirements conducting iterative reviews and effectively managing the submittal process.
6. Describe processes for continuous inspections and non-destructive testing to identify and correct deficiencies in the Work, in addition to specified testing and inspecting.
7. The CQC Plan is required to include a listing of Quality Control Check Points with a description of the work items that will be inspected and approved by the CQC Inspectors at each Quality Control Check Point prior to subsequent work proceeding. Submit with the CQC Plan copies of the Inspection Checklist blank forms that the Contractor intends to use for Checkpoint inspections. The partial listing below contains examples of work elements or conditions that the Authority would expect to be included in the CQC Plan as Quality Control Check Points. The Authority may at any time require that the Contractor add Quality Control Check Points and corresponding Inspection Checklists to the CQC Plan.
  - a. Pre-activity meeting agenda and meeting minutes prior to the start of any major work activity.
  - b. At specified intervals of embankment construction.
  - c. At completion of bridge embankment or excavation, and before the start of structure foundation.
  - d. Layout of structure piles, foundations, superstructure elements, civil work, utilities or other work.
  - e. Prior to closing of any form work.
  - f. Prior to any concrete placement (formwork, reinforcing, embeds, shaft conditions, joint lay out, post tension ducts, bearings, etc.).
  - g. Bearings prior to girder / beam erection.
  - h. Sub-grade verification prior to base material or sub-ballast placement.
  - i. Sub-ballast verification prior to rail and ballast placement.
  - j. After falsework is completed and prior to loading.

- k. Sub-grade or base verification (as applicable) before surfacing placement.
  - l. Verification of trench bottoms for underground utility work.
  - m. After placement of pipe or box culvert sections.
  - n. Prior to backfill operation at any structure, utility or facility.
  - o. Prior to post tension or pre-stress jacking operations.
  - p. Prior to welding.
  - q. Prior to directional boring.
  - r. Paving, prior to any traffic striping.
  - s. Substrate, prior to any specialized work (e.g.: fiber wrap, water proofing, tie-downs, etc.)
8. Maintain testing and inspection reports, including a log of approved and rejected results. Indicate corrective actions either proposed or taken to bring non-conforming portions of the Work into compliance. Comply with requirements of all authorities having jurisdiction.
- a. All test and inspection results shall be reviewed by the CQC Manager.
  - b. Any results which are not in compliances should result in the issuance of a Non-Conformance Report (NCR) by the CQC Manager.
  - c. The NCR should be filed by the CQC Manager within 7 calendar days of the results being issued.
  - d. The CQC Manager shall maintain the NCR Tracking Log.
- B. Contractor Quality Control Manager Qualifications
  - C. Contractor's Statement of Responsibility
  - D. Contractor's Testing Agency Qualifications
  - E. Schedule of Tests and Inspections

## **1.08 REPORTS AND DOCUMENTS**

- A. Tests and Inspection Reports
- B. Manufacturer Technical Representative Field Reports
- C. Factory-authorized Service Representative Field Reports



D. Permits, Licenses, and Certificates

**1.09 QUALITY ASSURANCE**

- A. General: Qualifications paragraphs in this Section establish the minimum qualification levels required: individual Specifications sections specify additional requirements.
- B. Manufacturer Qualifications
- C. Fabricator Qualifications
- D. Installer Qualifications:
- E. Professional Engineer Qualifications
- F. Specialists
- G. Testing Agency Qualifications
- H. Manufacturer Technical Representative Qualifications
- I. Factory-authorized Service Representative Qualifications
- J. Pre-construction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply as follows:
- K. Contractor's responsibilities include all of the following:
1. Provide test samples that are representative of proposed products and construction.
  2. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
  3. Provide sizes and configurations of site-assembled test assemblies and mockups, as well as laboratory mockups to adequately demonstrate the capability of products to comply with specified performance requirements.
  4. Build site-assembled test assemblies and mockups using installers who will perform the same tasks for the completed Work.
  5. Build laboratory mockups at testing facility using personnel, mockups and methods of construction indicated for the completed Work.
  6. When testing is complete, remove test specimens, assemblies, and mockups. Do not reuse such products on the Project.
- L. Mockups: Before installing portions of Work requiring mockups, build mockups for each form of construction and finish required to comply with following requirements, using materials indicated for completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Engineer.
2. Notify Resident Engineer seven (7) days in advance of dates and times when mockups will be constructed.
3. Demonstrate proposed range of aesthetic effects and workmanship.
4. Obtain Resident Engineer's approval of mockups before starting Work, fabrication, or construction.
5. Allow seven days for initial review and each re-review of each mockup.
6. Maintain mockups during construction in undisturbed condition as standard for judging completed Work.
7. Demolish and remove mockups when directed, unless otherwise indicated.

### 1.10 QUALITY CONTROL

- A. Contractor Responsibilities: Quality Control tests and inspections shall be the sole responsibility of the Contractor. The Contractor shall perform additional quality control activities necessary to verify that the Work complies with specified requirements.
1. Unless otherwise indicated elsewhere in the Contract Documents, Contractor shall provide quality control services required to verify that the Work complies with the Contract Document requirements, whether specified or not, in addition to testing and inspections required by authorities having jurisdiction (e.g. fire marshal, building official, Caltrans, SCRRRA, BNSF, etc.).
  2. Where quality control services are indicated as the Contractor's responsibility, the Contractor shall engage a qualified testing agency to perform the required quality control services.
    - a. Contractor shall not employ same entity engaged by Authority for testing and inspection unless agreed to, in writing, by Authority.
    - b. Contractor shall notify testing agencies at least 48 hours in advance of time when the Work that requires testing or inspecting will be performed.
    - c. Contractor shall submit a certified report, in duplicate, of each quality-control service performed.
    - d. Contractor shall submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
  3. Any testing or inspecting requested by Contractor but not required by the Contract Documents shall be Contractor's responsibility and sole expense.

- B. **Manufacturer Field Services:** Where indicated, engage a factory-authorized service representative to observe and inspect field-assembled components and equipment installation, including connections to utilities/services. Report all results in writing.
- C. **Manufacturer Technical Services:** Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Such services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials used, observation of installer's activities, inspection of completed portions of the Work, and submission of written reports.
- D. **Re-Testing and Re-Inspection:** Regardless of whether original tests or inspections were Contractor's responsibility, Contractor shall provide quality control services, including re-testing and re-inspection, for any construction that replaced portions of the Work that failed to comply with the Contract Documents.
- E. **Testing Agency Responsibilities:** Testing Agency shall cooperate with all parties in performance of Testing Agency's duties. Testing Agency shall provide qualified personnel to perform required tests and inspections.
  - 1. Notify the Construction Manager and Contractor promptly of irregularities or deficiencies observed in the Work during the performance of Testing Agency's services.
  - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  - 3. Conduct and interpret tests and inspections, and state in each report whether the tested and inspected work complies with or deviates from the specified requirements.
  - 4. Submit a certified test report, in duplicate, of each test, inspection, and similar quality-control service through the Contractor.
  - 5. Do not release, revoke, alter, or increase the Contract Documents requirements, or approve or accept any portion of the Work.
  - 6. Do not, in any way, perform any duties of the Contractor.
- F. **Associated Services:** Cooperate with testing agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested.
  - 1. See also Quality Coordination procedures for further description of associated quality-control services.

### 1.11 QUALITY COORDINATION

- A. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00, Submittal Procedures.
- B. Notify the Authority at least 48 hours in advance of time when Work that requires testing or inspecting will be performed. Also provide the following in support of testing and inspection services:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist testing agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Preliminary design mix proposed for use for material mixes that may require production control by testing agency.
  - 6. Security and protection for samples and for testing and inspecting equipment at Project site.
- C. Coordination: The Authority may engage a qualified testing agency to perform certain testing and inspection services for purposes of verifying quality and accepting completed portions of the Work. Contractor shall coordinate the sequence of activities to accommodate required quality assurance and quality control services with a minimum of delay and to avoid the necessity of removing and replacing construction to accommodate testing and inspecting. Cooperate with agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested.
- D. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents, which shall be submitted for information purposes. Submit the schedule within 30 days of the Authority's Limited Notice to Proceed.

### 1.12 SOURCE OF SUPPLY AND QUALITY OF MATERIALS

- A. The Authority shall approve the source of supply of each type of the materials supplied by the Contractor before the Contractor or subcontractor purchases or delivers these materials to the Project. Promptly after receiving the Contract award, the Contractor shall notify the Authority of all proposed material sources. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the Contractor shall furnish materials from other sources as approved by the Authority.

- B. Only materials conforming to Specifications and approved in advance by the Authority shall be used in the Work. All material being used shall be subject to inspection or test at any time during their preparation or use. NO materials or products determined to be unsatisfactory can be used in the Work.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 INSPECTION AND TESTING PROCEDURES**

The Contractor shall provide the Authority with full access to the Work and reasonable time for inspection for ascertaining whether or not the Work is performed in accordance with the requirements and intent of the Contract. No Work shall be covered or materials used without making the Work products or materials available for inspection by the Authority and any Work that is required to be uncovered, removed or replaced shall be at the Contractor's expense. Inspection will not relieve the Contractor from the responsibility of the quality of this Work and obligation to perform the Work in accordance with the requirements of these Contract Documents.

- A. All materials and every process of manufacture and construction shall be subject to inspection at all times. The Authority and his designated representatives shall have free access to all such operations. The Contractor shall furnish necessary materials and the Authority shall have the right to select suitable samples of materials for testing or examination which the Contractor shall supply without charge. In case such samples must be shipped to some other point for inspection or testing, the Contractor shall box or crate samples as necessary and shall deliver them to points designated for shipment without charge. Omission of inspection shall not relieve the Contractor of its obligations to perform the Work required by the Plans and Specifications. Non-conforming or defective materials not in compliance with Contract requirements shall be removed promptly from the vicinity of the Worksite, and the Contractor, at its sole expense, shall promptly remove, reconstruct, replace, and make good any defective Work. Oversight or error in the judgment of inspectors, or previous acceptance of the Work shall not relieve the Contractor from the obligation to correct any defects whenever discovered at the Contractor's sole expense. Authority and the other authorized agencies may inspect at any time the Contractor's production of Goods at off-site facilities, including any manufacturer's plant.
- B. Adequate facilities shall be made available for the necessary inspections and free access to all parts of the Work shall be available at all reasonable times. The Contractor shall have appropriate provisions inserted into each Subcontract it enters into providing for document, facility or in-plant Inspection by the Authority.
- C. In the event the Contractor does not correct nonconforming Work or remove rejected materials within a reasonable time fixed by written notice, the Authority may direct removals and corrections be performed by other Contractors. The charges for such removals and corrections shall be deducted from the Contractor's payment due under this Contract or may be paid for by the Contractor's bonds held for this Contract.

- D. All inspection by the Engineer is for the protection of the Authority and its interest and shall not relieve the Contractor of responsibility for performing work in accordance with the Contract Documents. After completing the Work, a final inspection will be made and any previous inspection or acceptance will not preclude rejection at the time of final inspection for any item that is not satisfactory to the Authority or not in accordance with the Contract Documents.
- E. In the event, within such period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Document, whichever is longer, any of the Work is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct it promptly after receipt of a written notice from the Authority. This obligation shall survive acceptance of the Work or termination of the Contract. In the event the Authority prefers to accept or not require correction of defective or nonconforming Work, the Authority may do so instead of requiring its removal and correction, in which case the Authority shall determine an appropriate sum to be deducted from the Contract price or otherwise charged against the Contractor, which determination shall be final and binding upon the Parties. Such monetary adjustment shall be effected whether or not final payment has been made.
- F. All defective Work, which has been rejected, shall be remedied or removed and replaced by the Contractor at its own expense in a manner acceptable to the Authority.
- G. The Authority may charge the Contractor for any additional costs it incurs for tests and Inspections, wherever and whenever Work is not ready at the time indicated by the Contractor's notice or when an additional reinspection is necessitated by prior rejection.
- H. The Authority will have access, at all reasonable times, to the Contractor's documents, calculations, supporting materials, data, and information concerning the Work, including computer programs and printouts, which supportive information Authority may determine is required to review the Work properly and expeditiously.

### **3.02 TEST AND INSPECTION LOG**

- A. Contractor shall prepare a record of tests and inspections, and shall include the following:
  - 1. Date test or inspection was conducted
  - 2. Description of the Work tested or inspected
  - 3. An Inspection Checklist appropriate to the portion of Work
  - 4. Date test or inspection results were transmitted to Authority
  - 5. Identification of testing agency or special inspector conducting the particular test or inspection service

- B. Maintain log at Project site. The Contractor shall post changes and modifications as they occur. The Contractor shall provide access to the test and inspection log for the Authority's reference during normal working hours. No notice will be required for Authority's access to Contractor's test and inspection the logs and associated documents.

### **3.03 REPAIR AND PROTECTION**

- A. General: On completion of testing, inspecting, sample taking, and similar services, the Contractor shall repair damaged construction and restore substrates and finishes.
- B. The Contractor shall provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as nearly invisible as possible.
- C. The Contractor shall protect construction exposed by or for quality-control service activities.
- D. Repair and protection are the sole responsibility of the Contractor, regardless of the assignment of responsibility for quality-control services.

### **3.04 AUTHORITY'S REMEDIES FOR DEFICIENT WORK**

If any Work provided by the Contractor is determined to be deficient, the Authority shall provide written notice to the Contractor of enumerating such deficiencies, and may thereafter do one or more of the following:

- A. Require the Contractor to promptly segregate and remove rejected Work from the Project at Contractor's own expense and without any extension of Contract Time.
- B. Require the Contractor re-perform repair or replace Work, products, materials or other items or items at Contractor's own expense.
- C. Withhold payments otherwise due to Contractor hereunder.
- D. Have remedial Work performed and products or materials provided by others at the sole expense of the Contractor.
- E. Terminate the Contract and obtain the remedies provided for therein.
- F. Corrected or remedial Work and replaced or repaired products or materials shall be subject to all of the Contract Documents requirements, including without limitation all standards of performance set forth in this Contract.
- G. Costs for re-testing and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor and the Contract Price will be adjusted by Change Order.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section;
- B. The Testing Agency engaged by Authority for testing and inspection will be provided and paid by the Authority. All other services of this Section will be paid by the Contractor.

**END OF SECTION 01 40 00**



## SECTION 01 43 23

### CONTRACTOR QUALIFICATIONS AND REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section outlines requirements and provisions to which the Contractor shall provide professional construction staff and equipment capable of safely executing the Work required by these Contract Documents part of which are on an operating railroad system, with little or no disruption to the passenger/commuter and freight operations, as well as other public facilities.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 14 16, Coordination with SCRRA
- B. Section 01 31 00, Project Management and Coordination
- C. Section 01 35 23, Site Safety Requirements

##### 1.03 GOVERNING REGULATIONS

- A. SCRRA: Maintenance of Way Operating Rules
- B. SCRRA: Track Maintenance Manual, FRA: Title 49 CFR Part 213 and Part 214
- C. Cal/OSHA: California Occupational Safety and Health Administration Regulations
- D. CPUC: California Public Utility Commission General Orders

##### 1.04 SUBMITTALS

- A. The Contractor shall submit the resumes for all personnel listed herein to the Authority within 15 days after the Limited Notice to Proceed. Each resume shall provide sufficient detail to demonstrate compliance with the appropriate specifications. Submit the number of each classification of employee to be assigned to the Work and the duration of their assignments.
- B. The Authority will review the submitted personnel resumes to determine compliance with all specified requirements. The Contractor shall not substitute or remove Authority approved personnel from the Contract without prior approval from Authority and shall not resubmit personnel that are deemed unacceptable by the Authority. The Authority must be notified and approve thirty (30) Days in advance, Contractor's planned substitution or removal of key personnel. Any removal or substitution of personnel without SCRRA consent shall be identified as contractual noncompliance. The Contractor shall submit a list of the equipment proposed to be used to the Authority for approval. This list shall have sufficient detail to demonstrate compliance with the appropriate Specification Sections.

- C. The Contractor shall submit a list of the equipment proposed to be used to the Authority for approval, within 15 days after the Award. This list shall have sufficient detail to demonstrate compliance with the appropriate Specification sections, regulatory authorities, and Railroad Operators.
- D. All equipment other than railroad track and ballast equipment shall be equipped with multi tonal directional “white noise” backup alarm that complies with OSHA Regulation 1926.601(b)(4). The Contractor shall submit a list of the equipment proposed to be used to the Authority for approval prior to NTP.
- E. Contractor Qualifications: The Contractor shall submit a company resume of all projects the Contractor has performed within a live railroad operating environment. Project experience shall include Class 1 railroads or Commuter and Passenger Rail. The Contractor shall submit a resume of performing Contract Work as a prime contractor on live active railroads for a minimum of 3 projects.
- F. The Contractor or their designated on-site personnel shall have attended a South Coast Air Basin Fugitive Dust Control Class within the last two years (SCAQMD Rule 403).

#### **1.05 RAILROAD CONSTRUCTION PROJECT MANAGER**

- A. The Contractor shall have a Railroad Construction Project Manager who will manage and coordinate the overall aspects of the track, station, grade crossing, site civil, systems, and bridge construction. The Railroad Construction Project Manager’s qualifications and experience must include the following:
  - 1. At least five years of progressively more responsible engineering, construction, and maintenance experience on a wide variety of Railroad projects for a Class 1 or Commuter Railroad. The Project Manager shall have experience on at least three (3) Class 1 or Commuter Railroad projects, managing construction related activities in an active railroad operating environment with moderate to heavy traffic and limited work windows.
  - 2. Knowledge of FRA standards and qualified under FRA Track Safety Standards, Part 213.7, applicable CPUC General Orders, the General Code of Operating Rules, SCRRRA Track Maintenance, Right-of-Way, and Structures Engineering Instructions, SCRRRA Standard Plans, and Railroad Roadway Worker Protection rules and regulations.
  - 3. A demonstrated ability to work safely and supervise individuals in safe work.
  - 4. Previous positions and experience supervising and planning work activities of construction superintendents, project engineers, and support personnel foreman and crews.
  - 5. The ability to read and understand track, bridge, station, construction plans and specifications, and SSWPs, and to develop and work from construction schedules.

- B. The Railroad Construction Project Manager must be located at the Contractor's construction field office; and be able to respond immediately to emergency or problem calls, seven days a week, 24 hours a day.
- C. This Railroad Construction Project Manager shall have the necessary authority to receive and promptly execute instructions and orders from the Authority or its authorized representatives. The Project Manager shall not be replaced without advance approval by the Authority. Any replacement Project Manager shall be subject to the approval of the Authority.

## 1.06 RAILROAD TRACK CONSTRUCTION MANAGERS

- A. The Contractor shall have at least one Railroad Track Construction Manager who will direct the day-to-day operations of the Track Foreman and assist in managing and coordinating the overall aspects of the track, station, grade crossing, and bridge construction. The Railroad Track Construction Manager's qualifications and experience must include the following:
  - 1. Thorough knowledge of railroad methods of track construction and maintenance under traffic.
  - 2. Knowledge of FRA standards, and qualified under FRA Track Safety Standards, Part 213.7, applicable CPUC General Orders, the General Code of Operating Rules, SCRRRA Track Maintenance, Right-of-Way and Structures Engineering Instructions, SCRRRA Standard Plans, and Railroad Roadway Worker Protection rules and regulations.
  - 3. The ability to work safely and supervise individuals in safe work.
  - 4. Previous positions/experience that include supervising and planning work activities of foreman and crews.
  - 5. The ability to read and understand track, site civil, systems, and construction plans.
  - 6. Five years' railroad track construction experience, with a minimum three years of railroad management experience. Must have at least three years' experience as a Roadmaster or equivalent position for a Class I Freight or Commuter Railroad in the last 15 years.
  - 7. The ability to identify FRA or other defects in track for the given class, and to prescribe appropriate remedial measures.
- B. The Railroad Track Construction Manager(s) must be located at the Contractor's construction field office and must be on the job during any track or associated construction work. The Railroad Track Construction Manager shall be able to respond immediately to emergency or problem calls on a seven-day-a-week, 24-hour basis. The Railroad Track Construction Manager will manage and directly oversee the safety, condition, and quality of track that has been modified by the Contractor, and shall direct corrective and maintenance measures to keep the track operating safely at the designated class.

- C. The Railroad Track Construction Managers shall be solely dedicated to this Project and not permitted to work on other projects during any track or associated construction work.

#### **1.07 MAINTENANCE CONTRACT MANAGER (MCM)**

- A. The Contractor shall have a MCM to plan, direct, and coordinate the activities of the Contractor (including all Subcontractors) in performance of the Work to assure compliance with Contract terms and conditions, applicable regulations, SCRRRA standards, , coordination with other Authority Contractors and public agencies, and provision of quality railroad service by the Authority. Serves as the point of contact for Authority staff for all matters relating to the Agreement and performs regular consultation and planning meetings with the Authority's Manager of Maintenance. The MCM shall review, revise, and develop contract submittal documents including annual budgets and work plans, training schedule and curriculums, CTOs, inspections, and invoices. The MCM shall assist training managers in developing training schedule and curriculum and shall supervise, promote, manage, transfer, and discipline Contractor staff and arrange with Authority for replacement personnel in the event of vacancies. The MCM is required to respond immediately to extraordinary conditions and to initiate inspections or repairs to track or facilities as required to maintain Authority facilities and operations.
- B. MCM qualifications and experience shall include the following:
  - 1. Twenty years of progressively responsible experience in railroad track maintenance or construction in an operating railroad environment including at least 10 years' experience in supervising or directing the work of others engaged in railroad track maintenance and five years' experience in managing construction or maintenance contracts.
  - 2. A minimum of ten years of supervisory skills in a similar position supervising and managing employees engaged in railroad track maintenance in an operating railroad environment.
  - 3. Desirable to have an associate degree from a College in Business, Construction or a related field.
  - 4. Knowledge of the safe and proper procedures for operating railroad maintenance hand and power tools and railroad maintenance equipment.
  - 5. Must be able to demonstrate ability to communicate in written and verbal English language with prior record keeping experience.
  - 6. Must possess strong leadership interpersonal skills.
  - 7. Detailed knowledge of FTSS and FRWS and the ability to be Qualified on Authority's examinations for 49 CFR Part 213.7 of FTSS and the GCOR related to these regulations at NTP.
  - 8. Previously qualified with a railroad to provide workplace protection under FRWS and to inspect track and supervise restoration of track under FTSS.

9. Knowledge of the physical layout and operation of a commuter rail system similar to Authority's.
10. Knowledge of the time for completion and the cost of repair for track and Right-of-Way facilities, and the ability to make value judgments regarding economic repair and/or replacement of these facilities.
11. Knowledge of the adjustment of thermal stress in continuously welded rail per 49 CFR Part 213.119 of the FTSS.
12. Ability to read and interpret drawings, plans, and specifications for railroad track and civil construction and to inspect track and supervise the work of others for compliance with these documents.
13. Ability to complete work under time pressures and to maintain composure under the stress of emergency situations.
14. Ability to perform scheduled and unscheduled repair or construction work at any time on any day of the week.
15. Must have, or obtain within six weeks of Limited NTP, a valid California driver license with no more than three moving violations and no Driving Under the Influence (DUI) in any state within the last three years.
16. Must pass a pre-employment physical examination including a drug and alcohol test.
17. Ability to work outdoors in all weather conditions, to lift objects weighing a minimum of 50 lbs. and must have the ability to distinguish colors and to hear warning signals and radio and telephone devices.
18. Shall be on-call 24 hours each day, 365 days a year, with allowances for vacations, sick leave, and related time off with duties assigned to the Assistant Contract Manager when off duty.

#### **1.08 RAILROAD BRIDGE CONSTRUCTION MANAGER**

- A. The Contractor shall have at least one Railroad Bridge Construction Manager who will direct the construction of all railroad bridges and culverts and assist in managing and coordinating the track and other work in the immediate vicinity of the bridge and culvert work. The Rail Bridge Construction Manager's qualifications and experience must include the following:
  1. Knowledge of railroad methods of railroad bridge construction and maintenance under traffic.
  2. Knowledge of FRA standards, and qualified under FRA Track Safety Standards, Part 213.7, applicable CPUC General Orders, the General Code of Operating Rules, SCRRRA Track Maintenance, Right-of-Way and Structures Engineering Instructions, SCRRRA Standard Plans, and Railroad Roadway Worker Protection rules and regulations.

3. The ability to work safely and supervise individuals in safe work.
  4. Previous positions/experience supervising and planning railroad bridge work activities of foreman and crews.
  5. The ability to read and understand bridge construction plans.
  6. Five years' railroad bridge experience, with a minimum of three years of Class I Freight or Commuter Railroad management experience within the last 15 years.
- B. The Railroad Bridge Construction Manager must be located at the Contractor's construction field office and must be on the work full time during the workweek for the full duration of any bridge or associated construction work. The Railroad Bridge Construction Manager will manage and directly oversee the safety, condition, and quality of any bridges modified by the Contractor, and shall direct corrective and maintenance measures to keep the track operating safely at the designated class. The Railroad Bridge Construction Manager must be able to immediately respond to emergency or problem calls, seven days a week, 24 hours a day.

#### **1.09 RAILROAD BRIDGE REPAIRER**

- A. The Contractor shall have a Railroad Bridge Repairer to perform maintenance, adjustment, inspection, and repair tasks to railroad structures using hand and power tools, construction equipment, and railroad maintenance equipment, performs work in accordance with the FRWS regulations, and additional duties within the general scope of the Services. The Railroad Bridge Repairer may work as a member of a crew, independently or under the direction of a Railroad Bridge Repair Leader and may direct the work of Railroad Track or Bridge Repairer Helpers.
- B. RBR qualifications and experience must include the following:
1. Three years experience in railroad bridge construction and/or maintenance with two years experience as a bridge maintenance worker using various machines for railroad bridge construction or maintenance work in an operating railroad environment.
  2. Familiar with the inspection, construction, and repair of structures constructed of pre-stressed and cast in place concrete, steel, timber, and combinations of these materials.
  3. Knowledge of safe and proper procedures for operating this equipment.
  4. Knowledge of safe and efficient manipulation of equipment and tools to perform construction and maintenance tasks.
  5. Knowledge of FRWS (including fall protection and rescue measures) and the ability to be Qualified on Authority's examinations for the GCOR related to these regulations within four weeks of Limited NTP.

6. Ability to complete work under time pressures and to maintain composure under the stress of emergency situations.
7. Ability to perform scheduled and unscheduled repair or construction work at any time on any day of the week.
8. Must have, or obtain within six weeks of Start Date, a valid California Class "A" driver's license with no more than three moving violations and no DUI's in any state within the last three years.
9. Must pass a pre-employment physical examination including a drug and alcohol test.
10. Ability to work outdoors in all weather conditions, to lift objects weighing a minimum of 50 lbs and must have the ability to distinguish colors and to hear warning signals and radio and telephone devices.

### **1.10 RAILROAD MACHINE OPERATORS**

The Contractor shall provide qualified Railroad Machine Operators and the Contractor will not be allowed to operate any equipment within the Authority Right-of-Way until the following requirements are met:

- A. Railroad Machine Operators qualifications and experience must include the following:
  1. Knowledge of railroad methods of track construction and maintenance under traffic,
  2. A Production/Switch Tamper Operator with at least two years of experience operating the make and model of the production/switch tamper assigned to this Contract Work. The tamper operators must fully understand the principles and practices of lining horizontal, spiral, curves, and tangents and vertical curves, and know how to read and utilize "cut sheets" and "alignment sheets" provided by a survey crew.
  3. At least one full-time production/switch tamper operator shall be assigned to each tamper, with three years' experience in railroad track construction and/or maintenance, two years' experience as a machine operator, and one year of experience operating machinery in use on this Contract Work, specifically including the following:
    - a. Ballast Regulator
    - b. Backhoe Tractor
    - c. Ballast Stabilizer
    - d. Pettibone Speed Swing
- B. Railroad Machine Operators shall be qualified under SCRRA's General Code of Operation Rules (GCOR) and Roadway Worker Protection rules.

- C. Must have a valid California Class "CA" driver's license with no more than three moving violations and no DUI's in any state within the last three years.
- D. Must pass a pre-employment physical examination including a drug and alcohol test.
- E. Ability to work outdoors in all weather conditions, to lift objects weighing a minimum of 50 lbs. and must have ability to distinguish colors and to hear warning signals and radio and telephone devices.

### 1.11 TRACK FOREMAN

The Contractor shall have a Track Foreman with the following qualifications and experience:

- A. Knowledge of railroad methods of track construction and maintenance under traffic.
- B. Knowledge of FRA standards, and qualified under FRA Track Safety Standards, Part 213.7, and SCRRRA Track Maintenance, Right-of-Way and Structures Engineering Instructions.
- C. Previous qualification with a railroad to obtain track and time and working time; to place and remove restrictions for train movement; and the ability to qualify under all Authority requirements.
- D. The ability to work safely and supervise individuals in safe work.
- E. The ability to read and understand track and construction plans.
- F. Five years' railroad track experience, with a minimum two years' track foreman experience.
- G. Track foremen shall be dedicated full time to the Project.
- H. Must have a valid California Class "CA" driver's license with no more than three moving violations and no DUI's in any state within the last three years.
- I. Must pass a pre-employment physical examination including a drug and alcohol test.
- J. Ability to work outdoors in all weather conditions, to lift objects weighing a minimum of 50 lbs. and must have ability to distinguish colors and to hear warning signals and radio and telephone devices.



**1.12 RAILROAD TRACK EQUIPMENT REPAIRER**

- A. The Contractor shall have a Railroad Track Equipment Repairer to perform inspection, analysis, repair and maintenance of several types of heavy equipment including rail-mounted tamping and surfacing machines, ballast regulators, compactors, and brooms, rail mounted all-terrain cranes, rail mounted heavy duty trucks equipped with hydraulic cranes and log loaders, and all-terrain construction equipment including end loaders, backhoe tractors, bulldozers, and road graders. The Railroad Track Equipment Repairer shall lubricate working parts, change engine and hydraulic oil and filters, clean and change air filters, tighten bolts, inspect and adjust fluid levels, belt tension, and dimensioned measurements (e.g. cross level of track), and perform safety inspections of equipment per FRWS using wrenches, screwdrivers, and other small hand and power tools. The Railroad Track Equipment Repairer shall performs heavy repair, analysis, and component exchanges in accordance with manufacturer's recommendations using power and hand tools, hydraulic booms and jacks, and electronic measuring and testing devices and shall establish and implement a schedule of preventive maintenance for equipment, order repair components and parts, and maintain an inventory of consumable parts and supplies that minimizes the time equipment is out of service for repairs and maintenance.
- B. Railroad Track Equipment Repairer qualifications and experience must include the following:
1. Five years experience in maintenance of heavy equipment and three years experience in the maintenance of railroad track construction and/or maintenance equipment including diesel engine, hydraulic system, electronic control, surfacing tamping machine, and rail guide wheel equipment.
  2. Knowledge of safe and proper procedures for operating this equipment in accordance with both the FRWS and the manufacturer's recommendations.
  3. Knowledge of FRWS and the ability to be Qualified on Authority's examinations for the GCOR related to these regulations within two weeks of Limited NTP.
  4. Ability to complete work under time pressures and to maintain composure under the stress of emergency situations.
  5. Must have a valid California Class "A" driver's license with no more than 3 moving violations and no DUI's in any state within the last 3 years.
  6. Must pass a pre-employment physical examination including a drug and alcohol test.
  7. Ability to work outdoors in all weather conditions, to lift objects weighing a minimum of 50 lbs and must have the ability to distinguish colors and to hear warning signals and radio and telephone devices.

8. Ability to communicate in the written and verbal English language.

### **1.13 RAILROAD TRACK EQUIPMENT REPAIRER HELPER**

- A. The Contractor shall have a Railroad Track Equipment Repairer Helper (Helper) to work under the supervision of the Railroad Track Equipment Repairer. The Helper may work independently or as a member of a crew as directed only for the purpose of servicing and maintaining equipment.
- B. Railroad Track Equipment Repairer Helper qualifications and experience must include the following:
  1. One to three years experience in the maintenance and repair of construction equipment or small work equipment.
  2. Knowledge of safe and proper procedures for operating this equipment in accordance with both FRWS and the manufacturer's recommendations.
  3. Knowledge of safe and efficient manipulation of equipment and tools to assist in track, structures or right-of-way related maintenance tasks.
  4. Knowledge of FTSS and FRWS and the ability to be Qualified on Authority's examinations for the GCOR related to these regulations within two weeks of Start Date.
  5. Ability to complete work under time pressures and to maintain composure under the stress of emergency situations.
  6. Must have, or obtain within two weeks of Start Date, a valid California Class "A" driver's license with no more than 3 moving violations and no DUIs within the last 3 years.
  7. Must pass a pre-employment physical examination including a drug and alcohol test.
  8. 8, Ability to work outdoors in all weather conditions, to lift objects weighing a minimum of 50 lbs and must have the ability to distinguish colors and to hear warning signals and radio and telephone devices.
  9. 9. Ability to communicate in the written and verbal English language.

### **1.14 RAILROAD TRACK WELDERS**

- A. The Contractor shall provide Railroad Track Welder with the following qualifications and experience:
  1. Knowledge of railroad methods of track construction and maintenance under traffic.
  2. The ability to work safely and supervise individuals in safe work.

- B. The Contractor shall provide Railroad Track Welder trained and qualified to perform the following procedures:
  - 1. Qualified in writing by the manufacturer of the thermite process rail welding kits to install field welds
  - 2. Weld cast manganese steel frogs
  - 3. Grind, dress and trim frogs, points and stock rails
  - 4. Weld and grind rail ends to correct mismatch
  - 5. Perform light fabrication arc welding
  - 6. Knowledge of FRA standards, and qualified under FRA Track Safety Standards, Part 213.7
  - 7. Five years' railroad track experience with a minimum two years of track welding experience
- C. Railroad track welders shall be available as needed to the Project for the duration of track-welding activities.

#### **1.15 TRACK AND STRUCTURES LABORER/WELDER HELPER**

The Contractor shall provide Mandatory Track and Structures Laborer/Welder Helper as needed for the project with the following qualifications and experience:

- A. Knowledge of railroad methods of track construction and maintenance under traffic.
- B. The ability to work safely at heights.
- C. The ability to work safely on operating railroad right of way.
- D. All Welder Helpers and 50 percent of the Track and Structures Laborers must have a minimum of one year of general track construction or maintenance experience.

#### **1.16 SAFETY REPRESENTATIVE**

- A. The Contractor shall provide a Safety Representative with minimum qualifications as set forth in the Special Conditions, as well as knowledge of FRA standards and qualified under FRA Track Safety Standards, Part 213, Railroad Workplace Safety, Part 214, applicable CPUC General Orders, the General Code of Operating Rules, SCRRRA and railroad physical characteristics, SCRRRA Track Maintenance, Right-of-Way, and Structures Engineering Instructions, and Roadway Worker Protection rules and regulations.
- B. The Safety Representative must be located at the Contractor's construction field office and must be on the Work Site when construction activity is occurring. The safety representative may be one of the other Authority approved positions identified in Section 01 43 23. .

- C. Must have a valid California Class "CA" driver's license with no more than three moving violations and no DUI's in any state within the last three years.
- D. Must pass a pre-employment physical examination including a drug and alcohol test.
- E. Ability to work outdoors in all weather conditions, to lift objects weighing a minimum of 50 lbs. and must have ability to distinguish colors and to hear warning signals and radio and telephone devices.
- F. Ability to communicate in the written and verbal and Spanish language.

### **1.17 SIGNAL ENGINEER**

- A. Signal Engineer as used herein shall be understood to mean the Contractor's railroad signal engineer or engineers approved by the Authority.
- B. Signal construction and installation personnel shall work under the Authority of the Signal Engineer. The Contractor's signaling construction forces shall work under the Authority of a Signal Engineer.
  - 1. Signal Engineer shall plan, direct, and oversee the adjustment, installation, and testing of signal related work and shall coordinate signal work with related track construction work and roadway work.
  - 2. Signal Engineer shall be responsible for all work under his charge and must have the Authority to remove any personnel from the project who are not performing the work in a satisfactory manner. The Signal Engineer shall obtain, review, and maintain documentation of the required minimum experience, a copy of the Electrician's license(s), and a record of wage rate paid for each Signal Electrician that performs Signal or Crossing Warning System work prior to that Electrician starting any Signal related work. This documentation shall be available for review by the Authority at all times upon request.
  - 3. Signal Engineer shall be on site whenever signal related work or track construction work is in progress in the vicinity of existing wayside signaling equipment, highway grade crossings, and/or cabling.

- C. Signal Engineer shall direct and organize the performance of all tests on signaling equipment and systems, prior to requesting the release of systems for service. The Signal Engineer shall be responsible to ensure that all applicable test documentation other than that documentation provided by the Authority, is completed prior to, or immediately after, in-service testing is completed. The Signal Engineer shall demonstrate experience in the philosophy, application, and testing requirements of the various signaling systems. The Signal Engineer shall have a minimum of 10 years signal supervisory or management related experience on a Class I railroad, or commuter railroad comparable to SCRRA. The Signal Engineer shall also demonstrate knowledge of the governing General Code of Operating Rules, including CPUC and FRA regulations and procedures. This demonstration shall be by interview of the Signal Engineer by the Authority prior to commencement of any work that may affect the signal system. The Work of this project includes working within tight windows on a live railroad consisting of freight trains, inter-city passenger trains, and SCRRA commuter trains. Candidate shall have a similar level of experience. The Authority's decision concerning the candidate's qualifications will be final. The Contractor shall not begin any signaling related Work prior to obtaining Authority's approval of each Signal Engineer. The Contractor shall obtain Authority approval of and provide additional Signal Engineers as required depending upon the level and type of Work being performed. Propose alternate personnel if the original candidate is found unacceptable.
- D. The Contractor shall propose alternate personnel if the original candidate is found unacceptable. Previous qualification as a Signal Engineer on other SCRRA projects does not constitute qualification as a Signal Engineer for this Contract.
- E. The Authority reserves the right to disqualify any Signal Engineer, at any time during the course of the Work. This right is at the sole discretion of the Authority and is not subject to protest or appeal.

#### **1.18 SIGNAL MANAGER**

- A. Signal Manager as used herein shall be understood to mean the Contractor's railroad signal manager or managers approved by the Authority. The Signal Manager shall report to and work under the direct Authority of the Signal Engineer and shall supervise and direct the work of all signal construction and installation personnel.

- B. The Signal Manager shall demonstrate experience in the philosophy, application, and testing requirements of the various signaling systems. The proposed Signal Manager shall have a minimum of 3 years signal supervisory or management related experience on a Class I railroad or commuter railroad comparable to SCRRA. The Signal Manager shall also demonstrate knowledge of the governing General Code of Operating Rules, including CPUC and FRA regulations and procedures. This demonstration shall be by interview of the Signal Manager by the Authority prior to commencement of any Work that may affect the signal system. The Work of this project includes working within tight windows on a live railroad consisting of freight trains, inter-city passenger trains, and SCRRA commuter trains. Candidates shall have a similar level of experience. The Authority's decision concerning the candidate's qualifications will be final. The Contractor shall not begin any signaling related Work prior to obtaining the Authority's approval of the Signal Manager. The Contractor shall obtain approval of and provide additional Signal Managers as required depending upon the level and type of work being performed.
- C. The Contractor shall propose alternate personnel if the original candidate is found unacceptable. Previous qualification as a Signal Manager on other SCRRA projects does not constitute qualification as a Signal Manager for this Contract.
- D. The Authority reserves the right to disqualify any Signal Manager at any time during the course of the Work. This right is at the sole discretion of the Authority and is not subject to protest or appeal.
- E. Must have a valid California Class "CA" driver's license with no more than three moving violations and no DUI's in any state within the last three years.
- F. Must pass a pre-employment physical examination including a drug and alcohol test.
- G. Ability to work outdoors in all weather conditions, to lift objects weighing a minimum of 50 lbs. and must have ability to distinguish colors and to hear warning signals and radio and telephone devices.

#### **1.19 SIGNAL ELECTRICIAN**

- A. Signal Electrician, as used herein, shall be understood to mean the Contractor's electrician(s) used to perform wiring and installation of railroad signal and grade crossing warning system circuits, component, and control equipment and devices including their primary and backup power supply systems.

- B. The Signal Electricians shall have a minimum 1,000 hours of experience in the wiring and installation of railroad signal and grade crossing warning system circuits, components, control equipment and associated devices including their primary and backup power supply systems. Signal Electricians shall perform the wiring, labeling and connection/continuity/resistance testing, as appropriate, of all railroad signal and grade crossing warning system circuits, components, control equipment and associated devices including their primary and backup power supply systems. All Signal Electricians shall be licensed Journeyman or Inside Electricians or equal. Signal Electricians shall be paid at the prevailing wage rate for the locality of the construction.
- C. The Contractor shall propose alternate personnel if the original candidate is found unacceptable. Previous qualification as a Signal Electrician on other SCRRA projects does not constitute qualification as a Signal Electrician.
- D. The Authority reserves the right to disqualify any Signal Electrician at any time during the course of the Work. This right is at the sole discretion of the Authority and is not subject to protest or appeal.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 PERSONNEL QUALIFICATIONS**

- A. Once personnel are deemed acceptable by the Authority, the Authority will make arrangements to provide the training and testing required for personnel to be qualified under subject areas described in Part 1 of this Specification Section.
  - 1. The Authority will provide approximately 40-hours of various training. The training course may cover parts of the Authority's General Code of Operating Rules, Maintenance of Way Operating Rules, Maintenance of Way Safety Rules, Fire Prevention Plan, and Track Maintenance Manual. Additional training will be determined by the Authority. The Contractor's managers and key personnel listed above in Subparts 1.5 through 1.7, 1.10 through 1.19 shall attend and successfully complete this course within 45 days after the Limited NTP. Successful completion shall be defined as becoming Qualified under these subject areas.
  - 2. The Contractor will be notified of test results in writing. The Authority will make arrangements for retesting if personnel fail the initial test. Retesting of the course material will be allowed one time within 55 days after the full NTP.

3. The Authority will provide an approximately 4-hour Roadway Worker Protection (RWP) training course. The RWP training course will cover the Authority's Roadway Worker Protection rules and regulations. The Contractor's managers, key personnel listed above in Subparts 1.4 through 1.7, 1.10 through 1.19, and subcontractors shall attend and successfully complete this course. All workers entering the Railroad right-of-way are required to complete the RWP training course.
- B. Substitutions. If the Contractor needs to replace any of the personnel described in Part 1, the above procedure shall be used. This process, including proficiency testing, shall be completed prior to the vacancy. The allowance of substitutions does not relieve the Contractor of his responsibility to provide the personnel in accordance with Part 1.
  - C. The Contractor shall provide the required personnel in accordance with Part 1. If the Contractor fails to provide the appropriate personnel due to a substitution or if the personnel described in Part 1 are not available within 30 days as specified in these Contract Documents, and the Contractor has not acted in good faith to secure replacement personnel, the Authority is entitled to implement one of the following options, at his sole discretion:
    1. Option 1: Suspend the portion of the Contractor's operation, which was under the direct supervision of the subject personnel, until the appropriate personnel are provided. All costs relating to this suspension of the Work will be the responsibility of the Contractor.
  - D. Option 2: Allow the Contractor's operation to proceed and deduct \$500 per day for each operation that was under the direct supervision of the subject personnel. If this option is used, this deduction shall be taken until the construction operation is completed or until the appropriate personnel are provided.
  - E. Immediately remove from the Work, when so ordered by the Authority, and not re-employ on any of the Work, without written permission from the Authority, any Contractor or SubContractor employee doing unsafe, improper, and defective Work; who, in the Authority's judgment, refuses or neglects the direction of the Authority given to the Contractor; who is deemed incompetent or disorderly; or who commits any trespassing on any public or private property in the vicinity of the Work.

### **3.02 RAILROAD CONSTRUCTION EQUIPMENT QUALIFICATIONS**

- A. The Contractor shall make the railroad construction equipment available for inspection a minimum of 30 days prior to its first use on the project, or as otherwise agreed upon with the Authority.
- B. The Contractor shall make arrangements for initial inspection of the equipment by the Authority. The railroad construction equipment shall not be operated on the Authority's Operating System until the initial inspection and approval is completed.



- C. The Contractor shall inspect all railroad construction equipment daily to ensure compliance with manufacturer instructions, FRA regulations, CPUC regulations, and the Authority's Operating and Safety Rules. The equipment not in compliance shall not be used on the Authority's Operating System.
- D. The Contractor shall provide the required equipment described in Part 1 to perform the work specified in these Contract Documents. Permission given by the Authority to use any particular methods, equipment, or appliances shall not be so construed to relieve the Contractor from furnishing other equipment or other appliances or adopting other methods when those in use prove unsatisfactory or as to bind the Authority to accept Work which does not comply with the Contract. Compliance with determinations by the Authority shall not relieve the Contractor from other obligations imposed by law or regulation nor serve as the basis of a Request for Change Order to the Work. Once mobilization is paid, if the Contractor fails to provide the appropriate equipment in accordance with Part 1, and if the Contractor has not acted in good faith in providing and maintaining the equipment, the Authority shall be entitled, at its own discretion, to implement one of the following options:
  - 1. Option 1: Suspend the Contractor's operation until the appropriate equipment is provided. All costs relating to this suspension of the Work will be the responsibility of the Contractor.
  - 2. Option 2: Allow the Contractor's operation to proceed and deduct \$500 per day for each piece of equipment not on the job site. If this option is used, this deduction shall be taken until the construction operation is completed or until the appropriate equipment is provided.

### **3.03 RAILROAD CONSTRUCTION EQUIPMENT**

- A. The Contractor shall have roadway work equipment used to move other railcars or equipment that is fully compliant with the FRA power brake, safety appliance, and wheel requirements, and shall be fully stenciled to indicate such compliance. The inspection and testing of the equipment, and the approval of the Contractor's operators, will be done by the Authority's Manager, Rules, and Training as scheduled by the Authority. The Contractor shall demonstrate to the Authority that the operator can make an initial brake test before moving any equipment or railcars, and obtain approval by inspection from the Authority, that equipment meets all safety appliance, maintenance, and clearance requirements.
- B. Unless amended by the Specifications, the Contractor shall have on hand and use the minimum equipment or approved equal listed below in performing the Work of the Contract Documents.
  - 1. A minimum of one Production/Switch Tamper—using models from the list below that are no older than 10 years from manufacture date—with all applicable attachments for construction surfacing:
    - a. Pandrol Jackson 6700 with Laser Liner
    - b. Tamper Mark IV with Laser Liner

- c. Plasser American Roadmaster 2000 or equivalent with Laser Liner
  2. One Unit Ballast Stabilizer, using a model of the Plasser PTS-62 Dynamic Track Stabilizer or equivalent that is no older than 10 years from manufacture date.
  3. A minimum of one Ballast Regulator or equivalent from the list below, using a model no older than 10 years from manufacture date:
    - a. Kershaw Model 26, or
    - b. Tamper Model BEB-15
  4. A minimum of one dust control tanker capable of spraying water with dust control additive in advance and during surfacing and brooming and regulating activities. The water tank shall have a capacity of at least 3,000 gallons.
  5. One Teleweld Series diesel or propane Fueled Heater Car.
  6. Three High-Speed Rail Drills – Geismar PR-8.
  7. Three Abrasive Rail Saws – Geismar MTX-50-S.
  8. Four Portable Hydraulic Toe Tampers – Geismar Model TT-1.
  9. Six Units Hydraulic Track Jacks – Simplex Model JJ1093.
  10. Hydraulic Rail Puller 100 tons+.
- C. The Contractor shall furnish all other on-track and off-track equipment necessary to complete the work.
- D. The Contractor shall maintain the equipment such that is operational and in proper working order. Measures that may be necessary, include, but are not limited to, the following:
1. Efficient scheduling and performance of required inspections, preventative maintenance, and service
  2. Promptly making any necessary repairs
  3. Containing hydraulic and other spills
  4. Keeping equipment owner's manual on board at all times
- E. Use of backup equipment not meeting the requirements listed above will be permitted subject to the following conditions:
1. The Authority approves the use of the proposed backup equipment, in advance.

2. The backup equipment is not used to perform contract work except as needed to return the tracks to service following an unforeseen breakdown of the required equipment. Use of backup equipment is considered a temporary measure until such reasonable time that the main equipment is repaired. This shall not exceed two consecutive workweeks.

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 43 23**

## **SECTION 01 55 26**

### **MAINTENANCE AND PROTECTION OF ROADWAY TRAFFIC**

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

##### **1.01 SUMMARY**

This Section specifies provisions for the Contractor furnishing, erecting and maintaining temporary barricades, changeable message signs, signs, flaggers, lights, road surfaces, pavement markings for detours, object markers and other safeguards necessary to protect the safety of the public during performance of the Project Work including but not limited to automotive traffic, pedestrian traffic, and bicycle traffic.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 35 23, Site Safety Requirements
- B. Section 01 56 37, Worksite Security Requirements
- C. Section 01 71 13. Mobilization and Demobilization and Controls

##### **1.03 REFERENCE STANDARDS**

- A. The Contractor shall comply with provisions of the most recent edition, including all addenda, of the following codes, specifications, standards, and recommended practices, except as otherwise indicated:
  - 1. CPUC - California Public Utilities Commission General Orders
  - 2. CALTRANS - State of California Department of Transportation Current or Latest Standard Specifications and Standard Plans
  - 3. CA MUTCD - California Manual on Uniform Traffic Control Devices
  - 4. SSPWC - Standard Specifications for Public Works Construction of the Joint Cooperative Committee
  - 5. WATCH - Work Area Traffic Control Handbook, latest edition
  - 6. Local Roadway Jurisdiction Requirements

##### **1.04 SUBMITTALS**

The Contractor shall comply with Local Agency Requirements including the preparation of all traffic control plans for the Grade Crossing Work, any advance message signs required by the local agencies. The Contractor shall coordinate approval for the traffic control plans for each Grade Crossing and obtain the no-fee traffic control and encroachment permits. The temporary warning devices shall be designed to minimize the inconvenience to the general public and shall comply with the regulations of the California Public Utilities Commission (CPUC) and governmental agencies having jurisdiction.

### 1.05 PROCEDURAL REQUIREMENTS

- A. The Contractor shall furnish construction signs, barricades, delineators, warning lights, CMS messages in advance of and during construction and all other devices used to implement the plan shall comply with California Manual on Uniform Traffic Control Devices or WATCH Manual latest edition, and local agency permit requirements. Providing all temporary warning devices in the incorporated areas of the project, as necessary, to convey traffic through the Project and as required by the permits.
- B. Flashing yellow beacons shall be used on all W20-1 signs and all Type II barricades guarding the work area overnight.
- C. The Contractor shall have all signs, delineators, barricades, and other devices properly installed prior to commencing construction. All signs shall be reflectorized and standard size. All delineators shall be 28" minimum portable, reflectorized and maintained erect in indicated position at all times, and shall be repaired, or cleaned as necessary to preserve their appearance and continuity.
- D. Additional traffic controls, signs, delineators or barricades may be required in the field. The Contractor shall be responsible for the placement of any additional devices necessary to assure safety to the public at all times during construction.
- E. Post "Temporary No Parking Tow Away" signs defining the time and date of any such restriction 72 hours prior to work.
- F. A. The Contractor shall be responsible for location and protection of traffic signal loop-sensors and signal and interconnect conduits. Where damage is caused by the Contractor's operation, the Contractor shall replace damaged City facility at no cost to the Authority or local jurisdiction.

### 1.06 DETOUR COORDINATION AND APPROVAL

Detour: In no case shall traffic be diverted from the existing traveled way without prior approval of the Authority and appropriate municipalities and local agencies. The following representatives of appropriate local agencies shall be notified 48 hours in advance of any detour or construction activities:

City Civil  
Engineer/Field  
Inspector/Traffic  
Engineer

Police Department (give location and duration)  
Fire Department

Transit Buses

Detour striping will not be permitted on any finish course of asphalt concrete pavement.

### PART 2 - PRODUCTS

All striping and marking shall conform to Section 310-5.6 of the Standard Specification for Public Works Construction. Temporary removable striping tape (detour grade) may be used in lieu of painted striping.

**PART 3 - EXECUTION**

- A. All traffic control devices shall be installed in accordance with Caltrans' current Standard Specifications and WATCH, Standard Plans; and CA MUTCD. In addition to work included above, the Contractor shall furnish and install guide markers and delineators at the locations indicated on the Contract Documents and where directed by the Authority.
- B. The Contractor shall provide for access to all adjacent properties during working hours. Construction operations shall be conducted in such a manner as to cause as little inconvenience as possible to abutting property owners/operators. The Contractor shall provide access to pedestrian all times. Construction operations shall be conducted in such a manner as to cause as little inconvenience as possible to pedestrian. Pedestrian shall be protected as required by CA MUTCD, Part 6D-1 or WATCH Manual Latest Edition, Section 11.
- C. The Contractor shall maintain on a 24-hour basis all signs, delineators, barricades, etc., to ensure proper flow and safety of traffic.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Traffic control work completed in accordance with the contract documents will 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 and equipment including furnishing, erecting, maintaining and removing barricades, traffic flaggers, construction area signs, temporary railing (Type K), portable changeable message signs, channelizers, supplies, supervision including preparing traffic control plans and obtaining traffic control and encroachment permits, and incidental materials and work necessary for controlling traffic during construction as described by the Contract Documents or required by the local jurisdiction.
- B. Full Compensation for furnishing and installing construction area traffic control devices as ordered by the Engineer, for the sole convenience and direction of public traffic shall be considered as included in the prices and no additional compensation will be allowed.

**END OF SECTION 01 55 26**

## SECTION 01 56 37

### WORKSITE SECURITY REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section addresses providing, operating, and maintaining security at the Work site during construction. "Security" refers to the protection of both Authority property and the property of the Contractor from theft, vandalism, pilfering or other destructive activities. It is the Contractor's sole responsibility to provide protection for any property (including equipment and supplies) under the Contractor's care, custody, and control.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 35 23 Site Safety Requirements
- B. Section 01 71 13 Mobilization and Demobilization and Controls

##### 1.03 REQUIREMENTS

- A. The Contractor shall establish, implement, and maintain an effective, site-specific Security and Loss Prevention Program (SLPP). The Contractor is solely responsible for record keeping and for ensuring that Subcontractors are informed of and comply with the SLPP.
- B. The Contractor shall comply with CCR Title 8, as well as all other federal, state, and local regulations, statutes, and codes applicable to security operations.
- C. Compliance with all parts of this Section shall be considered entirely the responsibility of the Contractor. No delays to the Contractor period of performance relating to any Worksite Security requirements will be allowed by the Authority.
- D. The SLPP shall comply with CFR 1926.800 (b) (3), which states: "The employer shall control access to all openings to prevent unauthorized entry underground. Unused chutes, manways, or other openings shall be tightly covered, bulkheaded, or fenced off and shall be posted with warning signs indicating 'Keep Out' or similar language." The SLPP shall include methods of protecting physical structures above, below, or at grade from trespassers and malicious mischief.
- E. The Contractor or subcontracted Security Firm(s), if utilized, shall coordinate with local law enforcement and with the Authority Security Department for patrol enhancement through the Authority's representative.
- F. The Contractor shall comply with the Authority requirements regarding the protection of the public, group tours, site visitors, and office safety.
- G. Prior to beginning work, Contractor shall contact local authorities to conduct a sweep of any encampments on or near the job site that may impact the work. Contractor shall work with local authorities to have periodic sweeps of encampments throughout the duration of Construction.

## 1.04 SUBMITTALS

- A. The Contractor shall submit, for acceptance by the Authority, a written site- specific SLPP that addresses both active and passive security measures to be implemented by the Contractor for project-related Work sites. This SLPP will be revised and resubmitted as conditions warrant and shall include at least the following:
1. Lighting/illumination – The Contractor shall provide and maintain adequate lighting throughout each Work site. This includes staging, laydown areas, and employee parking lots.
  2. Office Security – All Contractor office facilities shall be secured to prevent entry, and shall be provided with alarm systems.
  3. Physicals barriers – The Contractor shall provide and install perimeter fencing. Access areas shall be closed and locked at the end of shift or when work is completed in the area. Temporary construction protection fencing shall be required specific to job site activities.
  4. Project warning signage – The Contractor shall provide signs such as "Keep Out – No Trespassing." Or safety signs for pedestrians and/or other contractors and employees as required.
  5. Encampments: SLPP shall include Contractor's plan for controlling re-establishment of encampments if they exist on or around the job site after initial clearing.
- B. Should conditions change, the Contractor will be required to resubmit an updated, site-specific Security and Loss Prevention Program that reflects the changes in conditions. Any required resubmittal shall be considered within the original scope of this Contract, and shall be submitted in accordance with the Authority accepted submittal schedule so as to not delay the performance of Work by the Contractor.
- C. The Contractor shall not perform Work on the Work site for this Contract or any work order thereunder, until the Authority has returned the submittals marked "No Exceptions Taken." Authority refusal to issue permission to perform Work on the Work site, due to the Contractor's failure to submit listed safety submittals, or due to Authority rejection of unacceptable submittals, shall not constitute a basis for any claim of delay, interference, disruption, or other similar types of claims.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.01 SECURITY SERVICES AND EQUIPMENT

- A. Authority shall be contacted at the start of the project to determine the necessity of a security services and equipment.



- B. Select, provide, and retain a reputable uniformed armed security guard service. Security guards assigned by the security Subcontractor shall be assigned to only Project Work sites for patrol and other security related activities.
- C. Provide security guards with motor vehicles to enhance patrolling the entire Project during construction work activities, including holidays and weekends. Personnel assigned by the security Subcontractor shall perform only duties directly related to the security function.
- D. Security guards shall be equipped with cell phones to enhance their ability to report incidents in a timely manner and allow direct contact with emergency communications dispatchers.
- E. Security guards shall be provided with all necessary personnel protective equipment (PPE).

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 56 37**

## **SECTION 01 56 38**

### **BIRD PROTECTION**

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

##### **1.01 SUMMARY**

This work includes protecting migratory and nongame birds, their occupied nests, and their eggs. Nesting or attempted nesting by migratory and nongame birds is anticipated to occur but is not limited to March 15 through September 15.

##### **1.02 RELATED SECTIONS**

- A. Section 01 56 39, Temporary Tree and Plant Protection
- B. Section 01 71 13, Mobilization and Demobilization and Controls

##### **1.03 REGULATORY REQUIREMENTS**

- A. The Federal Migratory Bird Treaty Act (16 USC §703-711.), 50 CFR 10, and Fish & Game Code §3503, §3513, and §3800, protect migratory and nongame birds, their occupied nests, and their eggs.
- B. The Federal Endangered Species Act of 1973 (16 USC §1531,§1543) and California Endangered Species Act (Fish & Game Code §2050-§2115.5) prohibit the take of listed species and protect occupied and unoccupied nests of threatened and endangered bird species.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### **3.01 PROCEDURE**

- A. When migratory or nongame bird nests are discovered which may be adversely affected by construction activity, or when a bird is found injured or killed as a result of construction activity, immediately stop work within 100 feet (500 feet for raptors) of the nest or bird and notify the Authority. Work must not resume until the Authority provides written notification that work may resume at that location.
- B. When ordered by the Authority, use exclusion devices, nesting prevention measures or remove and dispose of partially constructed and unoccupied nests of migratory or nongame birds on a regular basis to prevent their occupation.

#### **PART 4 - MEASUREMENT AND PAYMENT**

- A. Exclusion devices, nesting prevention measures and nest removal that are ordered by the Authority will be paid for by Change Order.

- B. A delay to the controlling operation due to migratory or nongame birds or their nests will be considered a temporary suspension of work. Adjustments will be made for delays that the Authority determines are not due to the Contractor's failure to perform the provision of the Contract in the same manner as for suspensions due to unsuitable weather

**END OF SECTION 01 56 38**

## SECTION 01 56 39

### TEMPORARY TREE AND PLANT PROTECTION

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section concerns general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

##### 1.02 RELATED SECTIONS

- A. Section 01 32 33, Photographic Documentation
- B. Section 01 71 13, Mobilization and Demobilization and Controls
- C. Section 31 11 00, Site Clearing

##### 1.03 DEFINITIONS

- A. Caliper: Diameter of a trunk measured by the average of the smallest and largest diameters at 6 inches above the ground for trees up to and including, 4- inch size; and 12 inches above the ground for trees larger than 4-inch size.
- B. Plant Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and so indicated on Drawings.
- C. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

##### 1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification for each type of the following:
  - 1. Organic Mulch: A 1-quart volume of organic mulch, in sealed plastic bags labeled with the composition of materials by percentage of weight and source of mulch.
  - 2. Protection-Zone Fencing: Assembled samples of manufacturer's standard size made from full-size components.
  - 3. Protection-Zone Signage: Full-size samples of each size and text, ready for installation.

- C. Tree Pruning Schedule: A written schedule detailing the scope and extent of pruning of trees to remain that interfere with or are affected by construction.
  - 1. Species and size of tree
  - 2. Location on site plan; include a unique identifier for each
  - 3. Reason for pruning
  - 4. Description of pruning to be performed
  - 5. Description of maintenance following pruning
- D. Qualification Data: For qualified arborist and tree service firm.
- E. Certification: Certification from the arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards, and that trees were promptly and properly treated and repaired when damaged.
- F. Maintenance Recommendations: Recommendations from the arborist, indicating care and protection of trees affected by construction during and after completing the Work.
- G. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
  - 1. Use sufficiently detailed digital photographs or video.
  - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

#### **1.05 QUALITY ASSURANCE**

- A. Arborist Qualifications: Assign a Certified Arborist currently certified by ISA.
- B. Tree Service Firm Qualifications: Use an experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project, and that will assign an experienced, qualified arborist to the Project site during execution of the Work.
- C. Preinstallation Conference: Conduct the conference at the Project site. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
  - 1. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
  - 2. Means of enforcing requirements for protection zones.
  - 3. The Arborist's responsibilities.
  - 4. Field quality control measures.

## 1.06 PROJECT CONDITIONS

- A. The following practices are prohibited within protection zones:
  - 1. Storage of construction materials, debris, or excavated material
  - 2. Parking vehicles or equipment
  - 3. Foot traffic
  - 4. Installation of sheds or structures
  - 5. Impoundment of water
  - 6. Excavation or other digging unless otherwise indicated
  - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Topsoil: Use natural or a cultivated top layer of the soil profile or manufactured topsoil, containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil. Material should be reasonably free of subsoil, clay lumps, gravel, and other objects more than ½-inch in diameter; and free of weeds, roots, and toxic and other nonsoil materials.
- B. Topsoil Source: Obtain topsoil only from well-drained sites where topsoil is 4 inches deep or more; do not obtain from bogs or marshes.
- C. Organic Mulch: Should be free from deleterious materials and suitable as a top dressing for trees and shrubs, and consisting of one of the following:
  - 1. Type: Ground or shredded bark
  - 2. Size Range: 3 inches maximum, ½-inch minimum
  - 3. Color: Natural
- D. Protection-Zone Fencing: Fencing fixed in position and meeting one of the requirements specified below. Previously used materials may be used when approved by the Authority.

1. Wood Protection-Zone Fencing: Constructed of two 2-by-4-inch horizontal rails, with 4-by-4-inch preservative-treated wood posts spaced not more than 8 feet apart, and a lower rail set halfway between the top rail and ground.
  - a. Height: 4 feet
  - b. Lumber: Compliant with requirements in the Division 06 Section titled "Rough Carpentry."
2. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch maximum openings in the pattern and weighing a minimum of 0.4 lb/ft.; remaining flexible from minus 60 F to plus 200 F; inert to most chemicals and acids; minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi; secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet apart.
  - a. Height: 4 feet
  - b. Color: High-visibility orange, nonfading
- E. Gates: Single-swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 36 inches.
- F. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:
  1. Size and Text: As shown on Drawings
  2. Lettering: 3-inch-high minimum, using white characters on green background

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion and sedimentation control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- B. For the record, prepare a written report, endorsed by the arborist, listing conditions detrimental to tree and plant protection.

### **3.02 PREPARATION**

- A. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag each tree trunk at 54 inches above the ground.

- B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- C. Tree Protection Zones: Mulch areas inside tree-protection zones and other areas as indicated below. Apply a 4-inch average thickness of organic mulch. Do not place mulch within 6 inches of tree trunks.

### 3.03 TREE AND PLANT PROTECTION ZONES

- A. Protection Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin. Fencing should prevent people from easily entering the protected area except by using the entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in proximity to street intersections, drives, or other vehicular circulation.
  - 1. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to the Authority.
  - 2. Access Gates: Install a gate to provide access to the Protection Zone. Adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout its entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Protection Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by the Authority. Install one sign spaced approximately every 20 feet on protection-zone fencing, but no fewer than four signs with each facing a different direction.
- C. Maintain protection zones free of weeds and trash.
- D. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Authority.
- E. Maintain protection zone fencing and signage in good condition as acceptable to the Authority, and remove them when construction operations are complete and equipment has been removed from the site.
  - 1. Do not remove protection zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
  - 2. Temporary access is permitted subject to pre-approval in writing by the arborist if a root buffer effective against soil compaction is constructed as directed by the arborist. Maintain the root buffer so long as access is permitted.



### 3.04 EXCAVATION

- A. General: Excavate at the edge of protection zones and for trenches indicated within protection zones according to requirements in the Specifications titled "Earth Moving."
- B. Trenching near Trees: Where utility trenches are required within protection zones, hand-excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
- C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to the location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.
- D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

### 3.05 ROOT PRUNING

- A. Prune roots that are affected by temporary and permanent construction. Prune roots as shown on Drawings and as follows:
  - 1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
  - 2. Cut Ends: Coat cut ends of roots more than 1½ inches in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to the arborist.
  - 3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
  - 4. Cover exposed roots with burlap and water regularly.
- B. Root Pruning at Edge of Protection Zone: Prune roots 12 inches outside of the protection zone, by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

### 3.06 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction. Prune branches as shown on Drawings and as follows:

1. Prune trees that are to remain to compensate for root loss caused by damaging or cutting the root system. Provide subsequent maintenance during the Contract period as recommended by the arborist.
  2. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
    - a. Do not remove major branches that provide balance and shape to tree. If required, tie up branches that are required to remain, but extend beyond the tree protection zone.
    - b. Cut branches with sharp pruning instruments; do not break or chop.
    - c. Do not apply pruning paint to wounds.
- B. Chip removed branches and dispose of off-site.

### **3.07 REGRADING**

- A. Lowering Grade: Where new finish grade is indicated below the existing grade around trees, slope the grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below the existing grade around trees, slope the grade away from trees as recommended by the arborist, unless otherwise indicated.
- C. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
- D. Raising Grade: Where the new finish grade is indicated above the existing grade around trees, slope the grade beyond the protection zone. Maintain existing grades within the protection zone.

### **3.08 FIELD QUALITY CONTROL**

Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

### **3.09 REPAIR AND REPLACEMENT**

- A. General: Repair or replace trees, shrubs, and other vegetation that are indicated to remain or be relocated if damaged by construction operations, and in a manner approved by the Authority.
  1. Submit details of proposed root cutting and tree and shrub repairs.
  2. Have the arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
  3. Treat damaged trunks, limbs, and roots according to the arborist's written instructions.

4. Perform repairs within 24 hours.
  5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by the Authority.
- B. Trees: Remove and replace trees indicated to remain that are more than 40 percent dead or in an unhealthy condition before the end of the corrections period, or that are so damaged during construction operations that the Authority determines they are incapable of restoration to a normal growth pattern.
1. Provide new trees of the same size and species as those being replaced for each tree that measures 6 inches or smaller in caliper size.
  2. Provide two new trees of 6-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size. The species is to be selected by the Authority.
  3. Plant and maintain new trees as specified in the Division 32 Section titled "Plants."
- C. Soil Aeration: Where directed by Authority, aerate surface soil compacted during construction. Aerate 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch- diameter holes a minimum of 12 inches deep at 24 inches on center. Backfill holes with an equal mix of augered soil and sand.

### **3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS**

Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Authority's property.

### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 56 39**

## SECTION 01 57 19

### TEMPORARY ENVIRONMENTAL CONTROLS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

The Work specified in this Section consists of eliminating or minimizing air, water, and noise pollution generated by construction activities, and of complying with all legal requirements applicable to any construction generated hazardous wastes, including preparation and implementation of waste and wastewater management plans.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 35 44, Environmental Safety and Health Program
- B. Section 01 71 13, Mobilization, Demobilization and Controls

##### 1.03 REGULATIONS

The Contractor shall comply with all pertinent regulations including the following:

- A. State of California requirements relating to Air Resources Board (CARB), Code of Regulations (CCR), Health and Safety Code (CHSC), Regional Water Quality Control Board, and the Water Resources Control Board (SWRCB).
- B. Federal Code of Federal Regulations (CFR),
- C. U.S. Environmental Protection Agency (EPA), National Pollutant Discharge Elimination system (NPDES).
- D. The Federal Occupational Safety and Health Act (OSHA) and the California Occupational Safety and Health Act (CAL/OSHA).
- E. South Coast Air Quality Management District (SCAQMD).

##### 1.04 SUBMITTALS

The Contractor shall prepare and submit the following:

- A. Certificates that materials provided comply with Standard Specifications for Public Works Construction.
- B. The Contractor Generated Waste Management Plan - Required within 30 calendar days after the effective date of the Limited Notice to Proceed (LNTP) with required documents to properly govern the Contractor Generated Hazardous Wastes in accordance with Title 22, Division 4.5, CCR, and all other applicable laws and regulations. The Authority or its designee will have the right to review, modify, and approve this Waste Management Plan, and to provide quality assurance/quality control monitoring on the Contractor's implementation of this Plan.

- C. Stormwater Pollution Prevention Plan as required under the Clean Water Act and related federal and state laws and regulations: Required within 30 calendar days of effective date of LNTP. Authority or its designee will have the right to review, modify, and approve this SWPPP, and to provide quality assurance/quality control monitoring on the Contractor's implementation of this Plan.
1. Contractor shall be required to have a Qualified SWPPP (QSD) prepare this plan.
  2. Contractor shall implement this plan and provide a Qualified SWPPP Practitioner (QSP) for the duration of this project. Authority will designate a Legally Responsible Person (LRP) and will also provide a Data Submitter for uploading information into the SMARTS system.
  3. Contractor shall maintain site throughout all construction phases in a manner compliant with required SWPPP rules and regulations.
- D. Wastewater Management Plan - within 30 calendar days of the effective date of LNTP, the Contractor shall prepare and submit a Wastewater Management Plan for the project to the Authority for review and approval prior to beginning any work on the project site.
1. The Plan shall be prepared consistent with the provisions of the National Pollution Discharge Elimination System (NPDES) General Permit No. CAS000003 for Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction Activity adopted by the State Water Resources Control Board on September 2, 2012, as Order No. 2010-0014-DWQ (CGP).
  2. Submit monthly reports of daily monitoring wastewater discharges as specified in Paragraph 3.5.B. The Contractor shall identify in the Plan the specific Best Management Practices (BMP's) it proposes to use in connection with the execution of construction activity at the subject site. The Contractor shall use the applicable BMP's included in the Construction BMP Handbook, a web-based Portal prepared by the California Stormwater Quality Association (CASQA).
- E. The Contractor shall prepare permit applications and obtain permits not provided by Authority as necessary for performance of the Work under this Contract including, but not limited to:
1. Maintenance and protection of vehicle traffic.
  2. Excavation, dewatering and discharge of water and runoff into existing drainage systems or surface waters.
  3. Disposal of debris and soils.
  4. Disposal of track and related material.
  5. Removal of protected California Live Oak trees.
  6. All other activities with potential to adversely affect the environment.

7. Written permission from the property owner for right-of-entry work that requires entering private property.
8. Submit copies of permit applications and permits to the Authority.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 AIR POLLUTION CONTROLS**

- A. The Contractor shall comply with all requirements for controlling fugitive dust including specific impact mitigation measures contained in the latest version of the South Coast Air Quality Management District (SCAQMD) Rules and Regulations that include minimum procedures and techniques:
  1. Cover loads of materials, debris, and soil transported from construction sites. Trim or remove loose material from loads before leaving the Project. Do not cause or allow emissions of fugitive dust to remain visible in atmosphere beyond the property line of the emission source.
  2. Daily or more frequently, if necessary, water down and sweep adjacent streets, sidewalks, and bike paths that have heavy volumes of construction vehicles carrying debris and excavated materials.
  3. Establish regular cycles and locations for cleaning trucks that haul soil from site.
  4. Comply with dust control requirements identified in Section 01 71 13, Mobilization and Demobilization and Controls and water down construction sites as required for suppressing dust, during handling of excavation soil or debris, or during demolition.
  5. If conveyors are used, cover all transfer points along the conveyor system that is moving soil. Minimize the drop height to the stockpile. Provide a sprinkler system that will apply water to soil before it drops to stockpile.
  6. Any adapted measures developed by SCAQMD on Best Available Control Measures (BACM) for Fugitive Dust and Rule 403 will be incorporated into the site operations for Fugitive Dust Control.
- B. Burning of wastes is prohibited. Remove scrap and waste material and dispose of it in accordance with laws, codes, regulations, ordinances and permits.
- C. Use construction equipment designed and equipped to prevent or control air pollution in conformance with the most restrictive regulations of the EPA, state, and local authorities. Maintain evidence of such design and equipment and make it available for inspection by the Authority or its designee.
- D. Establish and maintain records of the routine maintenance program for internal combustion engine powered vehicles and equipment used on the Project. Keep records available for inspection by the Authority or its designee.

- E. During excavation, gases may be released from soil and from underground reservoirs. Gases may contain methane, other more complex hydrocarbons, or hydrogen sulfide, and may present hazards due to flammability or toxicity. Safety during construction is required by regulations of OSHA and CAL/OSHA. Although the composition, quantity, and concentration of gases that might be released are unknown, release of gases into the atmosphere may be subject to control by SCAQMD and the California Air Resources Board (CARB). The Authority will coordinate this issue with SCAQMD and CARB and will inform the Contractor of further required actions.
- F. In accordance with all regulations, perform a survey for asbestos containing materials and notify regulatory agencies including SCAQMD prior to renovation or demolition of any facility. Notify regulatory agencies prior to commencing Work on bridges or structures. Provide a copy of all notices to the Authority.
- G. Prevent or immediately remove "track-out" of material or dust onto public paved roadways, sidewalks, and bike paths. Daily or more frequently, if necessary, water down and sweep streets, sidewalks, and bike paths which have construction vehicles carrying debris and excavated materials to remove deposited materials or track out.

### **3.02 WATER POLLUTION CONTROLS**

- A. The Authority retains the sole right to determine whether discharged wastewaters will be discharged to the sanitary or the storm drain system. The Contractor shall treat wastewater, including storm runoff that is pumped from excavations and other water encountered during operations; remove suspended particles, pollutants, and hydrocarbons through settling basins or hydrocarbon separators in order to comply with Authority direction and regulatory criteria for pollutants in water set by state and local water agencies.
- B. The Contractor shall monitor wastewater discharge to ensure it meets standards set by appropriate laws, codes, regulations, ordinances and permits. Retain records of measurements for inspection by the Authority or its designee. Perform daily monitoring of wastewater discharges and record daily discharged quantities according to NPDES permit guidelines. Submit certified monthly reports not later than seven days after the end of the month.
- C. The Contractor is responsible for preventing or mitigating potential chemical releases, erosions and sedimentation impacts associated with storm water runoff.
- D. The Contractor shall provide copies of the approved Wastewater Management Plan to its Subcontractors and shall keep a copy available onsite at the project office. The Contractor shall provide amendments to the Wastewater Management Plan whenever there is a change in construction, operations, or where storm water runoff conditions which may affect the discharge of significant quantities of pollutants to surface waters, groundwater, or separate municipal storm sewer systems.
- E. An Authority approved Wastewater Management Plan does not relieve the Contractor or its Subcontractors of their responsibilities to comply with other state, county, and local governmental requirements, including those for storm water management or non-point source runoff controls.

### 3.03 SOLID AND HAZARDOUS WASTE CONTROLS

This Section applies to the Contractor Generated Hazardous Waste.

- A. The Contractor is responsible for, and shall indemnify, defend, and hold the Authority harmless against any costs (including attorney's fees and costs), demands, claims, damages, losses, delay costs ("Claims") arising from or associated with the management, abatement, removal, remediation, clean-up, transport, reuse, recycling, storage, and disposal of any Contractor Generated Hazardous Waste, or associated with any noncompliance with the Contractor Generated Waste Management Plan.
- B. In the event that the Contractor or the Authority reasonably suspects that the Contractor has generated, released, or discharged the Contractor Generated Hazardous Waste, the Contractor is to bear all costs of sampling and monitoring tests and other investigations to determine whether said waste is Solid Waste or Hazardous Waste in accordance with all federal, state and local requirements, including, without limitation, RCRA and Title 22, CCR Chapter 30, Article II (as amended, modified, or replaced from time to time). The Authority reserves the right (but not the obligation) to perform its own physical and chemical analyses and tests on suspected Contractor Generated Hazardous Waste. The Contractor shall furnish samples, at the Contractor's cost, as directed by the Authority.
- C. The Contractor shall be responsible for the management, abatement, removal, remediation, clean-up, transport, reuse, recycling, storage, and disposal of the Contractor-Generated Hazardous Waste in accordance with laws, rules, regulations, and orders, including, without limitation, Title 22, Chapter 30 et seq., California Code of Regulations, California Health and Safety Code Section 25100 et seq., Titles 23 and 26, California Code of Regulations, and regulations of the waste disposal facility to be used. Haul routes for transporting solid or hazardous wastes are subject to the approval of local jurisdictions, or other regulatory agencies.

### PART 4 - MEASUREMENT AND PAYMENT

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 57 19**



## **SECTION 01 60 00**

### **PRODUCT REQUIREMENTS**

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

##### **1.01 SUMMARY**

This Section includes administrative and procedural requirements relating to selection of products, materials and equipment for the Work and their delivery, storage, and handling.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 14 16, Coordination with SCRRA
- B. Section 01 25 00, Substitution Procedures
- C. Section 01 64 00, SCRRA Furnished Material and Equipment
- D. Section 01 78 36, Warranties and Guarantees

##### **1.03 MATERIAL SAFETY DATA SHEETS (MSDS)**

- A. The Material Safety Data Sheet is prepared by manufacturers and suppliers of products that contain hazardous materials. Hazardous material is defined as any substance which is a physical, or health hazard, or is included in the Cal-OSHA Director's List of Hazardous Substances or is listed in Title 22 of the California Code of Regulations, Section 12000, Chemicals Known to the State to Cause Cancer or Reproductive Toxicity (Proposition 65 Substances).
- B. No hazardous materials shall be delivered, stored, or used at any work site or facility unless they are properly labeled, tagged or marked, and a copy of the MSDS has been provided to the Authority. A copy of any updated MSDSs shall be provided to the Authority immediately.
- C. Hazardous materials shall not be stored within 25 feet of an Active Track without written approval of the Authority.
- D. The Contractor shall also maintain a file of relevant MSDSs at the work site. MSDS files shall be kept current; new or updated MSDSs shall be added immediately, and a copy provided to the Authority.

#### **PART 2 - PRODUCTS**

##### **2.01 PRODUCT SELECTION PROCEDURES**

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete functional installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. The Authority reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," the Authority will make the selection.
  5. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
  6. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Section 01 33 00, Submittal Procedures to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements. Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
  2. Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements. Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
  3. Basis of Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers.
  4. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Section 01 25 00, Substitution Procedures for consideration of an unnamed product by the other named manufacturers.
  5. Visual Matching Specification: Where Specifications require matching an established sample, select a product that complies with requirements and matches the Authority's sample. The Authority's decision will be final on whether a proposed product matches.
  6. If no product available within the specified category matches and complies with other specified requirements, comply with provisions in Section 01 25 00, Substitution Procedures for proposal of a product.

## 2.02 LISTING OF ELECTRICAL EQUIPMENT

- A. It is the Contractor's responsibility to ensure that electrical equipment, machinery control panels and electrical components, and field installed devices and components will meet all applicable codes and regulations of both local Authority and the State of California, for "listing" of electrical equipment by an accredited laboratory. Applicable provisions of all Underwriter's Laboratory standards, as incorporated under the laws within the State of California, shall apply to the work of this project, except as modified herein, and are hereby made a part of these Specifications to the extent required.
- B. The UL listing is acceptable; however, other certifications must be checked for acceptance under the applicable laws and regulations of the State of California and approved by the Authority prior to equipment purchase. Custom built control panels and systems, wherein listing has not been established prior to manufacture, will be accepted only if they are built under the UL self-certification labeling procedures. Compliance with, the costs of, and any scheduling impacts associated with the laws, codes and regulations of the state and local jurisdictions are the responsibility of the Contractor and its suppliers.

## PART 3 - EXECUTION

### 3.01 PRODUCT DELIVERY, UNLOADING, STORAGE, AND HANDLING

- A. The Contractor shall, at its own expense, deliver, unload, store, handle, and be responsible for all materials, whether furnished by the Authority or by the Contractor. All Authority furnished material, whether unloaded by the Authority or by the Contractor, shall be moved by the Contractor, at its expense, from the point where it is delivered by the Authority to the site of the Work.
- B. Deliver, unload, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions. The unloading, storing, and hauling of all the Authority's or the Contractor's material shall be considered as incidental to Contract pricing.
- C. Delivery and Handling:
  - 1. Schedule delivery to minimize long-term storage at the Project site, and to prevent overcrowding of construction spaces.
  - 2. Coordinate delivery with installation times to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  - 3. Deliver products to the Project site in an undamaged condition in the manufacturer's original, sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  - 4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

5. Track materials shall be handled and stored in accordance with the SCRRA Track Maintenance Manual and as per these specifications.

D. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units. Store products with seals and labels intact and legible.
2. Store materials in a manner that will not endanger Project structures and material shall not be placed nor stored within 25 feet of the centerline of any active railroad track.
3. Store products that are subject to damage by the elements under cover in a weather-tight enclosure above ground, or with impervious sheeting allowing for ventilation adequate to prevent condensation. Comply with the product manufacturer's written instructions regarding temperature, humidity, ventilation, and weather-protection requirements for storage.
4. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
5. Store cementitious products and materials on elevated platforms.
6. Store foam plastic away from exposure to sunlight, except to the extent necessary for a period of installation and concealment.
7. Protect stored products from damage and liquids from freezing.
8. Building materials will be stored in a protected environment safe from sun, rain, and excessive dust. Damaged or excessively dirty Materials will not be permitted to be installed.
9. All electrical and mechanical equipment shall be stored to be protected from rain, sun, wind, sand, dust, moisture, etc. The equipment shall be stored on supports off the ground or on a concrete slab with all factory-provided dust and moisture protection left in place until the equipment is installed. Electrical and mechanical equipment shall be maintained in accordance with the manufacturer's operation and maintenance instructions until the Contractor is relieved of the responsibility by the Authority.
10. When permission to do so is given in writing by the Authority, the Contractor may store materials and erect temporary buildings on Authority property, provided such property is not required for the Authority's use or is not under lease to other parties.

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 60 00**

## **SECTION 01 64 00**

### **SCRRA FURNISHED MATERIAL AND EQUIPMENT**

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

##### **1.01 SUMMARY**

The Authority may elect to furnish without cost to the Contractor a portion of the materials required for the Project. All materials that the Authority intends to furnish will be specified in the Project Specific Specifications. This Section includes administrative and procedural requirements for delivery, storage, and handling of Authority furnished products.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 11 16, Work by SCRRA
- B. Section 01 14 00, Work Restrictions
- C. Section 01 60 00, Product Requirements

##### **1.03 MATERIALS FURNISHED BY THE AUTHORITY**

- A. The material will be furnished at location(s) listed in the Project Specific Specifications. The Contractor shall furnish all labor and equipment necessary to load/unload, store, handle, and haul this material; to sort, as to type and size; and to load any excess material at the completion of the Project. Upon notification of the availability of material, the Contractor shall move the materials to the Project site without delay.
- B. The Contractor shall check all material upon receipt for quantity and condition, and after acceptance shall be fully responsible for properly protecting the material from loss or damage due to theft, fire, weather, or any other cause. For any of the material lost or damaged beyond repair after delivery, or for any of the materials not incorporated into the Work and not returned, the Contractor will be charged the same amount that the original materials cost the Authority, or amounts equal to replacement costs, whichever are higher. Any materials damaged after delivery to the Contractor, that the Authority, at its sole discretion, deems can be repaired satisfactorily, shall be repaired at the Contractor's expense and under the direction of the Authority.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 ARRANGEMENTS FOR AUTHORITY FURNISHED MATERIAL**

- A. The Contractor shall submit with the SSWP what Authority furnished materials are required and confirm with the Authority the location of the material. Unless otherwise stated in the Specifications, Project Specific Specifications or Special Conditions, all CWR and Crossties will be stored within the Project Right-of-Way limits. The Contractor shall make arrangements to pick up and transport these materials to the job site as needed.
- B. Within ten days of the NTP, the Contractor and the Authority shall conduct a joint inventory of the Authority furnished materials. The Contractor shall complete and update on a weekly basis the inventory of the Authority furnished materials, based on the use of the materials. Included in this inventory shall be information regarding amount of material removed from each storage location and its current location. In addition, the Contractor shall provide the Authority a log of all Authority furnished materials installed, to include a listing of the type, size, kind, and date/location where the material was installed, as well as a log of all Authority owned materials released or removed from the property.
- C. Authority furnished material of all types is to be protected from impact or being driven over by vehicles or equipment, from being buried in ballast or soil, from loss and theft, and from inefficient cutting and trimming.
- D. Unused Authority furnished materials shall be returned to the Authority at the location the material was made available to the Contractor by the Authority, or at other locations as specified in the Contract Documents. The Contractor shall legally dispose of all other unused material off-site.

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 64 00**

## SECTION 01 71 13

### MOBILIZATION, DEMOBILIZATION, AND CONTROLS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes Worksite mobilization of personnel, equipment, supplies, and appurtenances, all in ready and satisfactory working and operational order, which the Contractor intends to use for the Work; for the establishment of all temporary offices and Contractor-owned structures and other temporary facilities necessary to perform the Work; proper safety training of project personnel; and for incidental Work and operations which must be performed prior to beginning Work on the various Contract items. Also included is the demobilization or removal of all personnel, equipment, supplies, appurtenances, Contractor-owned structures, temporary facilities, materials, and debris from the Worksite and restoration of site and surrounding properties, affected by the Contractor's activities, to specified conditions.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 35 23, Site Safety Requirements
- B. Section 01 35 44, Environmental Safety and Health Program
- C. Section 01 56 37, Worksite Security Requirements
- D. Section 01 56 39, Temporary Tree and Plant Protection
- E. Section 01 57 19, Temporary Environmental Controls

##### 1.03 INFORMATIONAL SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Fire Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate the Contractor personnel responsible for management of fire prevention program.
- C. Moisture Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
  - 1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
  - 2. Indicate procedures for discarding water damaged materials, and protocols for mitigating water intrusion into completed Work and replacing water damaged Work.

3. Indicate sequencing of Work that requires water, such as sprayed fire-resistant materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
- D. Dust Control Plan: Submit coordination drawing and narrative that indicates the dust control measures proposed for use, proposed locations, and proposed time frame for their implementation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
1. Locations of dust control at each phase of work
  2. Watering duration and rewatering cycle, if watering is proposed as a dust-control measure
  3. Waste handling procedures
  4. Other dust-control measures

#### **1.04 QUALITY ASSURANCE**

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70 and the requirements of jurisdictional authorities.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

### **PART 2 - PRODUCTS**

#### **2.01 TEMPORARY FACILITIES**

The Contractor shall provide storage and fabrication sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations and shall store combustible materials apart from buildings and structures. Provide portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

#### **2.02 PROJECT SIGN**

Project sign shall be as per Engineering Standard ES5201. The Project sign shall be one 32 square foot aluminum panel sign mounted on two 2¼" x 2¼" square posts embedded in the ground. Bottom of the sign shall be 7' above ground.



**PART 3 - EXECUTION****3.01 PROTECTION OF EXISTING UTILITIES AND STRUCTURES**

- A. The Contractor shall maintain all utility facilities placed by the Contractor in temporary locations and all utilities that are shored or supported by the Contractor during construction. The cost of providing and maintaining all necessary or required temporary structures, and of making any necessary repairs, replacements, or similar operations, shall be paid by the Contractor; no separate payment shall be made.
- B. The Contract Price includes all costs that may be incurred by the need to remove or relocate existing public utilities or other structures, including public utilities or other structures identified at the time of the Bid due date. It is the Contractor's responsibility to schedule its Work and labor and equipment to minimize the impact of such delays and costs. Accordingly, except as provided in the California Government Code in the case of existing main or trunkline utility facilities, the Contractor agrees that its sole remedy resulting from any unreasonable delay or removal or relocation of such utilities will be an adjustment in accordance with the Change Order provisions of the Contract.

**3.02 PRESERVATION OF PROPERTY OR PROTECTION OF PROPERTY**

- A. The Contractor shall be responsible for the protection of public, private, and Authority property adjacent to and within the Work site, and shall be responsible for bearing the cost and performing the repair work necessary to restore or repair damaged areas.
- B. The Contractor shall supply all firefighting equipment, supplies, and personnel, and perform all Work required by the laws and regulations pertaining to fire prevention.
- C. Due care shall be exercised to avoid injury to existing improvements or facilities on adjacent property. The Contractor shall provide and install suitable safeguards to preserve and protect properties adjacent to the Work site from injury or damage. If such properties are injured or damaged by reason of the Contractor's operations, they shall be restored at the Contractor's sole expense. Damaged properties shall be repaired and restored to a condition as good as when the Contractor entered upon the Work site. The Authority may make or cause to be made such temporary repairs as are necessary to restore to service any damaged property. The cost of such repairs shall be borne solely by the Contractor, and the costs shall be deducted from any payments due or to become due to the Contractor under the Contract.
- D. Place steel plates to cover trenches and excavation outside of fenced construction areas at all times that Work is not ongoing. The steel trench plate shall be a minimum of 1 inch thick, with anti-slip coating or treatment and having sufficient bearing surface to support heavily loaded trucks and emergency equipment. The steel traffic plate shall be anchored and have approach ramping against movement.

### 3.03 TEMPORARY UTILITY INSTALLATION

- A. Electric Power Service: Provide electric power service and a distribution system of sufficient size, capacity, and power characteristics required for construction operations.
- B. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions. Install and operate temporary lighting that fulfills security and protection requirements without operating the entire system and install lighting for the Project identification sign.

### 3.04 STAGING AND LAYDOWN AREAS

- A. Staging and laydown areas for use in this Contract are as detailed in the Plans and Specifications. Staging and laydown areas not covered in the Contract Documents shall be requested in writing and approved by the Authority. This approval may or may not be granted by the Authority. No equipment may be operated or materials stored or placed for any period of time in unfenced areas closer than 25 feet from live tracks unless an Authority RWIC is present. The Contractor shall provide a fence to enclose each laydown or staging area within the right of way. The Contractor shall furnish the Authority with photographs of all staging and laydown areas to document their condition prior to the start of Work.
- B. The Contractor shall confine Work site operations to areas permitted by law, ordinances, permits, and the Contract.
- C. The Contractor shall relocate stored products, equipment, and materials that interfere with train operations, public and private utilities, or the visibility at railroad crossings. Materials and equipment shall not be piled, stored, or parked when not in use.
- D. As needed for the proper execution of the Work, the Contractor shall coordinate operations and secure additional storage/work areas from the property owners, at no cost to the Authority. The Contractor shall adhere to the noise levels and hours of local ordinances, except as provided and approved in the Site-Specific Work Plan (SSWP) in accordance with Section 01 14 00, Work Restrictions.
- E. The Contractor shall submit the proposed location of staging areas for the Authority's approval. No use of proposed locations shall be allowed prior to approval.
- F. In addition to site utilization limitations and requirements indicated on Contract Documents, the Contractor shall divide available space equitably among Subcontractors and other entities needing access and space so as to produce the best overall efficiency in performance of the total Work of the Project. The Contractor shall provide temporary parking areas for construction personnel.
- G. The Contractor shall schedule deliveries so as to minimize space and time requirements for storage of Materials and equipment on site, with minimal disruption to the adjoining site owners and operations. Pick-up and delivery requiring vehicular traffic adjacent to tracks shall be performed only during normal working hours, and as approved by the Authority.

### 3.05 ACCESS AND CONSTRUCTION ROADS

- A. Access to the Work from existing public roads, private property, or along the right-of-way of the Authority shall be arranged for and provided by the Contractor. No payment will be made to the Contractor by the Authority for any work done in constructing, improving, repairing or maintaining any road or structure thereon for use in the performance of the Work. The Authority assumes no responsibility for the condition or maintenance of any road or structure thereon that may be used by the Contractor in performing the Work or in traveling to and from the site of the Work.
- B. Existing roads and trails shall be used whenever possible for access to the Work. Construction of new access roads or use of existing roads shall be subject to approval by the appropriate governmental agency, landowner, and Authority. Temporary access roads shall be rehabilitated upon termination of the use of the road. The roads shall be graded to conform to original topography to the degree possible. Cut slopes shall be reduced to a grade consistent with adjacent topography, protected from erosion, and re-vegetated.
- C. The Contractor's haul or service road shall be located so that, upon the completion of the Work, a continuous road, where possible, will remain on the right-of-way throughout the entire length of the project. The Authority will designate the location of the road.
- D. Where it is necessary to place a portion of the haul or service road or occupy an area off of the Authority's right-of-way, the Contractor shall obtain written release from owner and tenant for the land involved. At the completion of the project, the area used by the Contractor shall be returned to a condition satisfactory to the landowner and duly constituted environmental agencies.
- E. At locations where the right-of-way crosses existing roads, highways, or at other locations where the Contractor's equipment will cross-existing roads or highways, the Contractor shall obtain the necessary approval and permits from the proper agencies for such crossings and detours as may be required. The Contractor shall maintain such crossings and detours in safe condition for passage of traffic; shall provide flag persons and watchmen as required; and shall furnish and maintain temporary drainage structures, guard fences, lights, warning signs, and other facilities necessary to protect traffic. Public access to the Contractor's road shall be controlled by cable barrier or gate that is locked with a series of padlocks including Authority and the Contractor locks. Such gates or barriers are to be maintained in a closed configuration except when in use. This Work shall be considered, as incidental to other items of the Contract, and no direct payment will be made for any costs involved.

- F. The Contractor may, upon approval of the Authority, construct temporary private railroad crossings for the purpose of performing the Work required. An Authority RWIC shall be provided at all such crossings at all times during construction. A physical barrier shall be provided to protect the crossing when not in use for construction. Access across the crossing may be limited by the presence of trains on the live track, as described in Section 01 14 00, Work Restrictions. Temporary crossings shall be removed upon completion of the Work. The Contractor shall submit plans for the Authority's approval. Any requirement for at-grade railroad crossings (other than public at-grade railroad crossings) or use of the Right of Way for the Contractor's equipment, vehicles, or materials shall be as approved by the Authority.
- G. All costs associated with the construction, maintenance, and removal of the haul or service road, and restoration of any area off the Authority's right-of-way will be considered, as incidental to other items of the Contract and no additional payment for any of this Work will be made.
- H. The Contractor shall provide dust-control treatment that is non-polluting and non-tracking. Reapply treatment as required to minimize dust.
- I. Upon completion of the Project, restore access and staging areas to a condition that is equal to or better than that prior to the Contractor entry, and as accepted by the Authority. All residual Materials shall be removed and all areas used shall be bladed smooth upon completion of use. Drainage in all areas affected by the Project shall be restored to a condition that ensures that no water ponds on the Right of Way, and no water is diverted to drain to the track structure. The Contractor shall photograph the project site(s) and submit the photographs to the Authority to demonstrate that staging and access areas have been restored to the pre-construction condition.
- J. Fences, walls, signs, and gates affected by the Contractor's access to the Right of Way shall be restored to full serviceability prior to demobilization.
- K. Maintain traffic controls, access for fire-fighting equipment and access to fire hydrants. Protect existing site improvements that are to remain, including curbs, pavement, and utilities.

### **3.06 LIMITATION ON THE USE OF HEAVY EQUIPMENT**

- A. If the Contractor anticipates using any vehicles or equipment over 20,000 pounds (loaded) during the performance of the Work, dimensions and weights of such equipment shall be submitted to the Authority for approval prior to use.
- B. Unless expressly permitted elsewhere in the Contract Documents, the Contractor shall not operate construction equipment or vehicles of any kind which, laden or unladen, exceed the maximum weight limits set forth in Division 15 of the California Vehicle Code over completed or existing base, surfacing, pavement, or structures.

### 3.07 HAZARDOUS CHEMICALS, WASTES AND MATERIALS

- A. Hazardous chemicals, wastes, and materials are defined as any product, substance, chemical, or material whose nature, quantity or intensity of existence, use, manufacture, disposal, transportation, spill, release, or effect, either by itself or in combination with other chemicals or materials in, on, or about the Work site:
1. is or becomes potentially injurious to the public health, safety or welfare, environment, or the Project site;
  2. is or becomes regulated or monitored by any governmental Authority; or
  3. may, according to statutory or common law theory, such as nuisance (public or private), waste, trespass, negligence, strict liability, or tort, be a basis for liability in tort, or be a basis for liability to third parties.
- B. The Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) prohibits employers from knowingly discharging or releasing a chemical or other material known to the State of California to cause concern, birth defects, or other reproductive harm into water or onto land where such chemical passes or probably will pass into any source of drinking water. Notwithstanding any provisions in this Act exempting the Contractor, the Contractor hereby agrees to comply with all provisions of the Act relating to the discharge of hazardous chemicals and materials on the Work site.
- C. The Contractor's employees and Subcontractors of any tier shall not discharge such chemicals or materials on the Work site that will result in the discharge of such chemicals, and shall, upon completion of performance of all other duties under this Contract, remove all supplies, materials, and waste remaining on the job site which if exposed, could result in the discharge of such chemicals, materials, and wastes.
- D. The Contractor, the Contractor's employees, and Subcontractors of any tier shall also comply with the State of California anti-smoking laws that, in part, prohibit smoking in the workplace and in enclosed areas.
- E. Should the Contractor, the Contractor's employees, Subcontractors of any tier, or their employees fail to comply within 24 hours from receipt of written notice of noncompliance from the Authority, or other Authority of competent jurisdiction, or within the time of an abatement period specified by such Authority of competent jurisdiction, whichever period is shorter, the Authority may give notice of default to the Contractor. Failure of the Authority, or other Authority of competent jurisdiction to issue notice to the Contractor shall not relieve the Contractor of its responsibilities under this Section.

### 3.08 PESTICIDES, FUEL OIL, AND GREASE

- A. The Contractor shall comply with all local, state, and federal rules and regulations of the Department of Food and Agriculture, the Department of Health, the Department of Industrial Relations, the Department of Toxic Substance Control, and all other agencies that govern the use of pesticides, fuel oil, and grease required in the performance of the Work. Fuel, oil, and grease include any crude oil or any products, byproducts, or fractions thereof.

- B. Pesticides include but shall not be limited to herbicides, insecticides, fungicides, rodenticides, germicides, nematocides, bactericides, inhibitors, fumigants, defoliants, desiccants, soil sterilants, and repellents.
- C. Any substance or mixture of substances intended for preventing, repelling, mitigating, or destroying weeds, insects, diseases, rodents, or nematodes, and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, shall be considered as a pesticide.

### **3.09 DISPOSAL OF MATERIALS OUTSIDE THE WORK SITE**

- A. Unless otherwise stated elsewhere in the Contract Documents, the Contractor shall make its own arrangements for disposing of materials outside the Work site. The Contractor shall obtain written permission or permit from the property owner on whose property the disposal is to be made. Prior to the disposal of any material at the intended location, the Contractor shall submit said written permission or permit to the Authority for approval, together with a written release from the property owner absolving the Authority from any and all responsibility related to the disposal of material on said property.
- B. Disposal of all Hazardous Materials shall be done in accordance with all laws and regulations. Copies of a required regulatory documentation, including copies of final manifests, shall be submitted to the Authority. No payment will be made for such work without proper and complete manifests.

### **3.10 SECURITY AND PROTECTION FACILITIES INSTALLATION**

- A. Site Enclosure Fence: Before construction operations begin, furnish and install a site enclosure fence in a manner that will prevent people and animals from easily entering the site except by entrance gates.
  - 1. Extent of Fence: As required to enclose the entire Project site or that portion determined sufficient to accommodate construction operations.
  - 2. Maintain security by limiting the number of keys and restricting distribution to authorized personnel. Furnish one set of keys to the Authority.
- B. Security Enclosure and Lockup: Install temporary enclosures around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at the end of each work day.
- C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- D. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

- E. Covered Walkway: Erect protective, covered walkways where identified on the Plans or directed by the Authority for passage of individuals through or immediately adjacent to the Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawings.
  - 1. Construct covered walkways using scaffold or shoring framing.
  - 2. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
  - 3. Paint and maintain appearance of walkway for duration of the Work.
- F. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage the fire-prevention program.
  - 1. Prohibit smoking in construction areas.
  - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to Contract requirements.
  - 3. Develop and supervise an overall fire prevention and fire protection program for personnel at the Project site. Review needs with the local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
  - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip them with suitable nozzles.
  - 5. Review and update Fire Risk Assessment form for Work.

### **3.11 PUBLIC SAFETY AND CONVENIENCE**

- A. The Contractor shall conduct its operations so as to offer the least possible obstruction and inconvenience to the public and shall have under construction no greater length or amount of work than can be prosecuted properly with due regard to the rights of the public. The Contractor shall control temporary noise from construction equipment by using work hour controls and maintenance of muffler systems on machinery.
- B. Construction shall be conducted so as to cause as little inconvenience as possible to abutting property owners. Convenient access to driveways, houses and buildings along the line of Work shall be maintained and temporary approaches to crossing or intersecting highways shall be provided and kept in good condition. When the abutting owner's access is to be eliminated and replaced by other access, the existing access shall not be closed until the replacement access facility is available.

- C. The Contractor, at its expense, shall provide adequate safeguards, safety devices and protective equipment and take any other needed action both of its own volition and responsibility or that which the Authority may determine is reasonably necessary to protect property, life, health and public safety in connection with the performance of the Work covered by the Contract.
- D. The Contractor shall make all reasonable efforts to maintain good will among landowners, tenants, lessees, and members of the general public and shall not knowingly violate any right of such persons in the performance of the Work covered by the Contract. To this end, the Contractor specifically agrees to not:
1. Leave gates, gaps, or fences open, unattended or insecurely fastened.
  2. Use private driveways or roadways without authority.
  3. Use land beyond limits of the right-of-way without authority
  4. Leave trash or debris on the land.
  5. Permit the personal misconduct of its employees or any of its Subcontractor's employees.
- E. In the event the Contractor's operations cause injury to any persons or damage to public or private property, including above and below ground structures, the Contractor shall immediately contact emergency services for the local Authority and within twenty-four (24) hours, give notification in writing to the Authority of such damage or injury. The Contractor shall be responsible and liable for all damages and injuries.
- F. Unless otherwise noted, all construction operations shall preserve existing drainage paths and vehicular and pedestrian access. The Contractor shall also regularly attend to dust, mud, trash, noise, debris, etc., caused by construction operations to prevent a public nuisance.
- G. All paved areas, including asphalt concrete berms cut or damaged as a result of construction, shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing the permit. All temporary and permanent pavements shall conform to the requirements of the affected pavement owner. All pavement that is subject to partial removal shall be neatly saw-cut in straight lines.
- H. In order to obtain a satisfactory junction with adjacent surfaces, the Contractor shall saw-cut back and trim the edge of the surface so as to provide a clean, sound, vertical joint before temporary or permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw-cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.



- I. Where sidewalks or bike lanes have been removed for purposes of construction, or damaged, the Contractor shall place properly protected, suitable temporary sidewalks including bike lanes, promptly after backfilling, and shall maintain them in satisfactory condition until the final restoration thereof has been made.

### **3.12 DISRUPTION MITIGATION**

- A. The Authority, the Authority's Contractors and other railroads will occupy the Work site during the entire construction period for the conduct of the Authority's and the railroad's normal operations. The Contractor shall cooperate with the Authority and the railroads, through the Authority, in scheduling operations to minimize conflicts so as to not interfere or impair the normal operation of the Authority or other railroads.
- B. The Contractor shall develop and submit for the Authority's approval a Disruption Mitigation Plan that identifies and establishes criteria for the performance of the Work that requires coordination and sequencing based on the operational requirements of the Authority and the other railroads, and to allow the free flow of public traffic within the public rights-of-way. The Contractor shall incorporate operational data and information and requirements given by the Authority, other railroads, and local municipal transportation agencies in developing the Disruption Mitigation Plan, and in planning and scheduling its work to prevent interruption or impairment of the normal operations of the Authority, the other railroads, and public traffic. The Contractor shall avoid disruptions to the normal operations of the Authority, other railroads, and public traffic, and shall plan, schedule, coordinate and construct the Work in such a way as to accommodate the normal operations of the Authority, other railroads, and public traffic.
- C. Upon the completion of each day's Work, the Contractor shall make the railroad tracks and facilities suitable for the passage of trains. The operation of trains over portions of the Work not completed will be in accordance with the FRA requirements. The operation of trains over such Work will not constitute Beneficial Occupancy.

### **3.13 OPERATION, TERMINATION, AND REMOVAL**

- A. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- B. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with a temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  1. Materials and facilities that constitute temporary facilities are the property of the Contractor. The Authority reserves the right to take possession of Project identification signs.

2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where an area is intended for landscape development, remove soil and aggregate fill that do not comply with the requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt, other petrochemical compounds, and other substances that might impair the growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

#### **PART 4 - MEASUREMENT AND PAYMENT**

- A. The measurement and payment for mobilization, maintenance, utilization, and demobilization of required facilities, personnel, materials and equipment under this Section shall 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. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for the Work of this Section.
- B. The Contract Price(s) will be paid as follows:
  1. When 10 percent of the Awarded Contract Price(s) is earned, excluding mobilization and amount paid for materials on hand, 40 percent of the amount bid for mobilization and demobilization will be paid.
  2. When 75 percent of the Awarded Contract Price(s) is earned, excluding mobilization and amount paid for materials on hand, 60 percent of the amount bid for mobilization and demobilization will be paid.
  3. 100 percent of the amount bid for mobilization and demobilization will be paid after the Authority has determined that the project work is complete in accordance with the Contract and technical specifications, and the Contractor has left the work site in a clean and acceptable condition.

**END OF SECTION 01 71 13**

**SECTION 01 71 23**  
**FIELD ENGINEERING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This Section includes general administrative and procedural requirements for field engineering and surveying for the Work including, establishing and maintaining baselines, design lines, grades and field control points as required for construction layout survey. The Work of this Section also includes field survey of existing track and track grade to verify final layout, point of switch stations, alignment, and grade for new turnouts and bridges and other structures.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 77 19, Project Closeout
- B. Section 01 78 39, Project Record Documents

**1.03 SUBMITTALS**

- A. Submit for the Authority's approval the name and professional history of the land surveying firm designated by the Contractor as its Project Surveyor. The Project Surveyor or professional engineer selected must be a current California State licensed land surveyor and have a minimum of five years of verifiable experience performing field surveys of railroad, track, and bridge alignments and related office engineering.
- B. On request, the Contractor shall submit to the Authority all documentation that verifies the accuracy of the survey work.
- C. Certificates and Site Drawings: Prior to Completion and when requested by the Authority, submit a certificate and site drawing signed by, a Land Surveyor, or Professional Engineer, certifying that the location and elevation of improvements are in conformance with Contract Documents.
- D. The Contractor shall submit a complete copy of the baseline survey field notes and final survey layout. The layout will include data and offset calculations.

**1.04 QUALITY CONTROL**

- A. The Contractor shall maintain a complete and accurate log of control and survey work as it progresses.
- B. The Authority reserves the right to check the Contractor's survey measurements and calculations. Whether the Authority exercises this right or not, the requirement for accuracy will not be waived.

- C. On completion of construction and major site improvements, the Contractor shall prepare a final certified survey illustrating dimensions, locations, angles, and elevations of the construction and the Work site.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

The Contractor shall verify locations of survey control points prior to starting any Work on the Project site. The Contractor shall immediately notify the Authority of any discrepancies discovered.

### **3.02 SURVEY REFERENCE POINTS**

- A. The Contractor shall locate and protect survey controls, existing benchmarks, control points, survey monuments, property corners and reference points and preserve permanent reference points during construction.
- B. The Contractor shall report to the Authority the loss or destruction of any reference points or relocation required because of changes in grades or other reasons.
- C. The Contractor shall replace dislocated survey control points based on the original survey control, and shall make no changes without prior written notice to and approval by the Authority.
- D. The Contractor shall report to the Authority the need to relocate permanent benchmarks or control points before proceeding.

### **3.03 FIELD ENGINEERING**

- A. Identification: The Authority will identify existing benchmarks, control points, and property corners. Control datum for the survey is indicated on the Drawings.
- B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks per mile on the Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for the type and size of benchmark.
  - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
  - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

### 3.04 CONSTRUCTION LAYOUT

- A. Before proceeding to lay out the Work, the Contractor shall verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, the Contractor shall notify the Authority promptly.
- B. General: Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices in accordance with the following:
  - 1. Establish benchmarks and control points to set lines and levels at each phase of construction and elsewhere as needed to locate each element of the Project. Establish limits on use of the Project site.
  - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 3. Inform Contractor of lines and levels to which they must comply.
  - 4. Check the location, line and grade of every major element as the Work progresses. Notify the Authority when deviations from required lines or grades exceed allowable tolerances. Such notification shall include a thorough explanation of the problem, and a proposed plan and schedule for remedying the deviation. Remedial work shall not proceed without the Authority's concurrence of the remediation plan. Work progressed after a deviation is noted shall be removed and redone at no cost to the Authority.
  - 5. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including top of rail, special track work, crossing panels, pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record any deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by the Authority.
- F. The contractor shall stake out location of the railroad warning devices and provide horizontal and vertical control survey sheet prepared by a registered surveyor and tied to the project survey control for grade crossings. This service is necessary to coordinate street geometry and curb return layouts with railroad signal contractor.

**3.05 SURVEYS AND RECORDS**

- A. Working from lines and grades established by baseline surveys as shown in relation to the Work, the Contractor shall establish and maintain benchmarks and other dependable markers to set lines and levels for Work on site as needed to locate each element of the Project.
- B. The Contractor shall calculate and measure required dimensions as shown on the Contract Drawings (within recognized tolerances if not otherwise indicated and immediately notify the Authority of any discrepancies. The Contractor shall use written rather than scaled dimensions.
- C. Where both dimensions relative to track and absolute dimensions (e.g. coordinates, elevations) are given, the dimensions relative to the track shall govern unless otherwise directed by the Authority.
- D. The Contractor shall inform tradesmen performing the Work of marked lines and grades provided for their use in layout work.
- E. The Contractor shall provide a complete copy of baseline survey field notes and final layout to the Authority prior to starting construction.
- F. In areas scheduled for excavation or embankment, the Contractor shall be responsible for a baseline cross-section survey suitable to document or verify actual topography prior to the start of Work. No adjustments will be made to earthwork quantities by means other than a sealed by licensed surveyor before-and-after survey, suitable to calculate volume based on average end areas, measured in either cut or fill areas. Load counts, truck weights, work duration, representative area deviations from bid schedule quantities, or other means of estimating earthwork volume will not be accepted, except for use in determining progress payments.
- G. The basis for dimensioning railroad track is the centerline between the rails and elevation of the top surface of the rail unless noted otherwise in the plans or the Specifications or by the Authority. On curved track with super-elevation, the elevation specified is that of the low rail (inside of curve) unless noted otherwise in the plans or the Specifications or by the Authority.

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 71 23**

## SECTION 01 74 19

### CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes administrative and procedural requirements for salvaging nonhazardous demolition and construction waste, recycling nonhazardous demolition waste and disposing of nonhazardous demolition and construction waste.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 57 19, Temporary Environmental Controls
- B. Section 31 11 50, Demolition, Cutting and Patching, for disposition of waste resulting from site clearing and removal of above- and below-grade improvements

##### 1.03 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

##### 1.04 PERFORMANCE REQUIREMENTS

- A. Facilitate recycling and salvage of materials to achieve maximum rates for salvage/recycling by weight of total non-hazardous solid waste generated. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators.
- B. Packaging: Regardless of salvage/recycle goal indicated above, salvage or recycle 100 percent of the following uncontaminated packaging materials, including paper, cardboard, plastic, polystyrene packaging and wood crates.

## 1.05 SUBMITTALS

- A. Within 14 days of the Limited Notice to Proceed, submit a Waste Management Plan according to ASTM E 1609, the requirements of the jurisdiction having Authority, and requirements in this Section. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use the same units of measure throughout the waste management plan. List each type of waste and whether it will be salvaged, recycled, or disposed of in a landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
- B. Waste Reduction Progress Reports: Submit a report concurrent with each Application for Payment. The report shall cover the period of the application for payment. Include the following information:
  - 1. Material category
  - 2. Generation point of waste
  - 3. Total quantity of waste, in tons
  - 4. Quantity of waste salvaged, both estimated and actual, in tons
  - 5. Quantity of waste recycled, both estimated and actual, in tons
  - 6. Total quantity of waste recovered (salvaged plus recycled), in tons
  - 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.01 PLAN IMPLEMENTATION

- A. Provide handling, containers, storage, signage, transportation, and other items as required to implement the waste management plan during the entire duration of the Contract.
- B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities. Designate specific areas on the Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

### 3.02 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to the Contractor.



- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at the Project site to the maximum extent practical, according to the approved construction waste management plan.
  - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from the Project site. Include a list of acceptable and unacceptable materials at each container and bin.
  - 2. Inspect containers and bins for contamination and remove contaminated materials (if found).
  - 3. Stockpile processed materials on site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 4. Stockpile materials away from the construction area. Do not store within the drip line of remaining trees.
  - 5. Store components off the ground, and protect them from the weather.
  - 6. Remove recyclable waste from Authority property and transport to a recycling receiver or processor.

### **3.03 DISPOSAL OF WASTE**

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from the Project site and legally dispose of them in a landfill or in another manner acceptable to authorities having jurisdiction.
  - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of to accumulate on site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Remove waste materials from the Authority's property and legally dispose of them.

## **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 74 19**

**SECTION 01 77 00**  
**SUBSTANTIAL COMPLETION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This Section addresses administrative and procedural requirements for Substantial Completion and beneficial occupancy.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 32 33, Photographic Documentation
- B. Section 01 77 19, Project Closeout
- C. Section 01 78 23, Operation and Maintenance Data
- D. Section 01 78 36, Warranties and Guarantees
- E. Section 01 78 39, Project Record Documents

**1.03 SUBSTANTIAL COMPLETION SUBMITTALS**

- A. The Contractor shall prepare and submit the following a minimum of 14 days prior to requesting inspection for determining the date of Substantial Completion.
  - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction granting the Authority unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 2. Submit closeout submittals specified in other Specifications Sections, including Project record documents, all QC Material testing and special inspection results, Final As-Built Schedule, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information, warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 3. Prepare and submit a schedule of maintenance material submittal items, including the name and quantity of each item and the name and number of the related Specification Section that identifies tools, spare parts, extra materials, and similar items, to be delivered to the location designated by the Authority.
  - 4. Submit test/adjust/balance records.
  - 5. Submit changeover information related to the Authority's occupancy, use, operation, and maintenance.

**1.04 SUBSTANTIAL COMPLETION PROCEDURES**

- A. The Contractor shall complete the following prior to requesting Substantial Completion;
1. Provide a Final As-Built Schedule that is approved by the Authority.
  2. Advise the Authority of pending insurance changeover requirements.
  3. Make the final changeover of permanent locks and deliver keys to the Authority. Advise the Authority of the changeover in security provisions.
  4. Complete the start-up and testing of systems and equipment.
  5. Perform preventive maintenance on equipment used prior to Substantial Completion.
  6. Instruct the Authority's personnel in the operation, adjustment, and maintenance of products, equipment, and systems.
  7. Advise the Authority of the changeover in utilities.
  8. Terminate and remove temporary facilities from the Project site, along with mockups, construction tools, and similar elements.
  9. Complete final cleaning requirements, including areas adjacent to the project site such as streets, curbs, gutters, swales and other drainage facilities. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
  10. Deliver tools, spare parts, extra materials, and similar items to the location designated by the Authority. Label with manufacturer's name and model number where applicable.
- B. The Contractor shall submit a written request for inspection to determine Substantial Completion a minimum of 14 days prior to the date the work will be completed and ready for final inspection and tests. On receipt of such request, the Authority will either proceed with the inspection or notify the Contractor of unfulfilled requirements. The Authority will prepare the Certificate of Substantial Completion and a Final Punchlist for Final Completion after inspection, or will notify the Contractor of outstanding items that must be completed or corrected before the certificate will be issued.
- C. The date of Substantial completion of the Work as allowed by the Contract Documents, is the date certified by the Authority when work is sufficiently complete, in accordance with Part A above and the Contract Documents, so the Authority may occupy or use the Work, or a designated part or portion thereof, for the use for which it is intended.

## 1.05 BENEFICIAL OCCUPANCY

- A. Section 01 14 00, Work Restrictions identifies requirements relating to Worksite access by the Contractor, Authority, and other third parties. In addition to those requirements, the Authority shall have the right to take Beneficial Occupancy of any portion of the Work. The Authority may at any time notify the Contractor in writing that it intends to take Beneficial Occupancy of any portion of the Work that is not otherwise complete. At the time of taking Beneficial Occupancy, the Contractor and the Authority shall make an inspection of that portion of the Work to determine its status of completion and shall prepare a list of the Work items remaining to be completed. During Beneficial Occupancy, the Authority shall allow the Contractor reasonable access to complete or correct items on the list and to complete the Work, but they shall have no tenancy. However, a failure of the Authority to list any item of Work shall not relieve the Contractor of responsibility for complying with the terms of the Contract. The Authority's possession or use shall not be deemed an acceptance of any Work under the Contract.
- B. Beneficial Occupancy shall not be deemed an acceptance of the Work. While the Authority is in such possession, the Contractor shall be relieved of the responsibility for maintenance, loss, or damage to that portion of the Work for which the Authority has taken Beneficial Occupancy other than that resulting from the Contractor's act or omission, negligence willful misconduct, or breach of warranty. If such possession or use by the Authority unreasonably delays progress of the Work or causes additional expense to the Contractor, an adjustment may be made in the compensation or time to perform the Work, in accordance with Contract Change Order Procedures.

## PART 2 - PRODUCTS

### 2.01 SPARE PARTS AND MAINTENANCE MATERIALS

Provide products, spare parts, maintenance and extra materials in quantities specified in Section 01 78 23, Operation and Maintenance Data and individual Specification Sections.

## PART 3 - EXECUTION

### 3.01 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning Procedures: Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project, or for a designated portion of the Project:
1. Clean the Project site, yard, and grounds in areas disturbed by construction activities—including landscape development areas—of rubbish, waste material, litter, and other foreign substances.
  2. Sweep paved areas broom-clean. Remove petrochemical spills, stains, and other foreign deposits.

3. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
4. Remove tools, construction equipment, machinery, and surplus material from the Project site.
5. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
6. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
7. Sweep concrete floors broom-clean in unoccupied spaces.
8. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to the manufacturer's recommendations if visible soil or stains remain.
9. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
10. Remove labels that are not permanent.
11. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
12. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
13. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
14. Clean ducts, blowers, and coils if units were operated without filters during construction, or if they display contamination with particulate matter on inspection.
15. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.

### **3.02 REPAIR OF THE WORK**

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to their specified condition.
- C. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
- D. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
- E. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
- F. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
- G. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 77 00**

## **SECTION 01 77 19**

### **PROJECT CLOSEOUT**

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

##### **1.01 SUMMARY**

This Section specifies procedures and requirements for Contract close out, including but not limited to final submittals, final acceptance, all required financial and legal documentation, and release of final payment to the Contractor at completion of the Contract Work.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 77 00, Substantial Completion
- B. Section 01 78 36, Warranties and Guarantees
- C. Section 01 78 39, Project Record Documents

##### **1.03 FINAL COMPLETION SUBMITTALS**

Submittals Prior to Final Completion: Before requesting final completion, the Contractor shall submit the following:

- A. Summary:
  - 1. Request Substantial Completion per Section 01 77 00.
  - 2. Provide final contract status report.
  - 3. Submit final contract cost and schedule summary.
- B. Closeout:
  - 1. Submit Certificate of Final Acceptance for Authority approval.
  - 2. Submit Notice of Final Completion.
  - 3. Submit Authority confirmation indicating that all inspections are complete.
  - 4. Submit Request for Final Acceptance.
  - 5. Submit Final Release.
  - 6. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with Contract insurance requirements.
- C. Compliance:
  - 1. Consent of the surety to final payment.

2. Provide all required Contract Compliance documents.
  3. Provide all required Labor Compliance documents in accordance with General Conditions.
- D. Financial:
1. Submit Request for Release of Retention / the Contractor Final Release.
  2. Submit Release of Retention Invoice.
  3. Final liquidated damages settlement statement, if applicable.
  4. Application for Final Payment shall include the following documentation:
    - a. Lien Releases from all Subcontractors and vendors that have filed preliminary notice of liens.
    - b. Certificate – “All Claims Resolved”
    - c. Certificate – “No Claims for all Subcontractors and vendors that have filed preliminary notice of liens”.
    - d. Certificate – “Warranties/Guarantees in Effect”
- E. Construction:
1. Submit final quantities log.
  2. Address and provide Authority documentation of completion of Punchlist items.
  3. Provide documentation of permit sign-off by third party agencies, as required and provide Certificates of Release from jurisdictional authorities.
  4. Final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion (or when the Authority took possession of and assumed responsibility for corresponding elements of Work), if applicable.
  5. Provide final report for Material testing and special inspections.
  6. As-Built Drawings.
  7. As-Built Schedule.
  8. Provide Warranties and Guarantees.
  9. Maintenance and Operations Manuals
  10. Certificate of Insurance: For continuing coverage if specified in Contract Documents.



11. Schedule of Maintenance Material Items for maintenance material submittal items specified in other Sections.

#### **1.04 ACCEPTANCE OF THE WORK AND CLOSEOUT**

- A. When the Contractor determines that the Work is fully completed, the Contractor shall submit the Authority a written Request for Acceptance of Work. Within 30 Days after receipt of the Contractor's Request for Acceptance of Work, the Authority shall review all requirements of the Work and either:
  1. Reject the Contractor's Request for Acceptance of Work, specifying defective or uncompleted Work items
  2. Accept the Work as complete by issuing to the Contractor a Certificate of Final Acceptance and approving the final payment.
- B. If the Authority rejects the Contractor's Request for Acceptance of Work, the Contractor shall promptly remedy the defective or uncompleted Work items. Thereafter, the Contractor shall again give Authority a written Request for Acceptance of Work. The foregoing procedure shall apply successively thereafter until Authority has issued the Contractor a Certificate of Final Acceptance.
- C. Authority reserves the right to direct any and all Punch List work prior to completion of Work or Final Acceptance. Notwithstanding any other provision of this Contract that could be interpreted to the contrary (including in Contract Documents of higher precedence), it shall be the Contractor's continuing responsibility to complete and deliver every portion, and the integrated whole, of the Work in accordance with all of the requirements of the Contract. The issuance of a Certificate of Substantial Completion by Authority shall not be construed to relieve the Contractor of this responsibility, or any part thereof. If, after the issuance of a Certificate of Substantial Completion, the Authority discovers any deficiency, or item not completed or otherwise requiring correction or remedial action, whether or not the item appears on any Punchlist or other list of clean up items, Authority may direct the work to be performed and the Contractor shall correct the deficiency, complete the item or otherwise remedy the condition to bring it into full compliance with the Contract prior to Final Completion and Authority's acceptance of the Work.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

#### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 77 19**

## SECTION 01 78 23

### OPERATION AND MAINTENANCE DATA

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

- A. Operation and maintenance documentation directory
- B. Emergency manuals
- C. Operation manuals for systems, subsystems, and equipment
- D. Product maintenance manuals
- E. Systems and equipment maintenance manuals

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 33 00, Submittal Procedures
- B. Section 01 79 00, Demonstration and Training
- C. Section 01 91 13, General Commissioning Requirements

##### 1.03 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction
- B. Subsystem: A portion of a system with characteristics similar to a system

##### 1.04 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content, formatted and organized as required by this Section.
  - 1. The Authority will approve the contents of operations and maintenance submittals.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file: Assemble each manual into a composite electronically indexed file, with functional bookmarks.
  2. Name each indexed document file in the composite electronic index with the applicable item name. Include a complete, electronically linked
  3. Operation and maintenance directory. Enable inserted reviewer comments on draft submittals.
- C. Initial Manual Submittal: Submit a draft copy for Authority approval of each manual at least 30 days before commencing demonstration and training. The Authority will comment on whether the general scope and content of the manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion, and at least 21 days before commencing demonstrations and training. The Authority will provide comments for revisions as needed.
- E. Correct or revise each manual to comply with the Authority's comments. Submit copies of each corrected manual within 15 days of receipt of the Authority's comments, and prior to commencing demonstration and training.

## **1.05 QUALITY ASSURANCE**

In preparation of operation and maintenance data, use personnel thoroughly trained and experienced in the operation and maintenance of the equipment or systems involved. Where manuals require written instructions, provide technical writing that clearly communicates essential data. Where maintenance manuals require drawings or diagrams, prepare drawings clearly, in an understandable format. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by those representatives and prepare manuals.

## **PART 2 - PRODUCTS**

### **2.01 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY**

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
1. List of documents
  2. List of systems
  3. List of equipment
  4. Table of contents
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment that are not part of a system, list alphabetically in a separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with the same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

## **2.02 OPERATION AND MAINTENANCE MANUAL FORMAT REQUIREMENTS**

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
  - 1. Title page
  - 2. Table of contents
  - 3. Manual contents
- B. Title Page: Include the following information:
  - 1. Subject matter included in manual
  - 2. Name and address of the Project
  - 3. Name and address of the Authority
  - 4. Date of submittal
  - 5. Name and contact information for the Contractor
  - 6. Name and contact information for the Authority
  - 7. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals
  - 8. Cross-reference to related systems in other operation and maintenance manuals
- C. Table of Contents: List each product included in the manual, identified by product name, indexed to the content of the volume, and cross-referenced to the Specification Section number in the Project manual.
- D. If operation or maintenance documentation requires more than one volume to accommodate data, include a comprehensive table of contents for all volumes in each volume of the set.

- E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- F. Manuals, Electronic Files: Submit manuals in the form of a multiple-file composite electronic PDF file for each manual type required.
  - 1. Electronic Files: Use electronic files prepared by the manufacturer where available. Where scanning of paper documents is required, configure the scanned file for minimum readable file size.
  - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in the manual directory and the table of contents. Group documents for each system and subsystem into individual composite bookmarked files. Then create a composite manual so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure the electronic manual to display the bookmark panel upon opening the file.

### **2.03 OPERATION MANUAL CONTENTS**

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections, as well as the following specific information:
  - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on the Contract Documents.
  - 2. Performance and design criteria if the Contractor has delegated design responsibility.
  - 3. Operating standards.
  - 4. Operating procedures.
  - 5. Operating logs.
  - 6. Wiring diagrams.
  - 7. Control diagrams.
  - 8. Piped system diagrams.
  - 9. Precautions against improper use.
  - 10. License requirements, including inspection and renewal dates.
- B. Descriptions: Include the following:
  - 1. Product name and model number. Use designations for products indicated on the Contract Documents. Include manufacturer's name, equipment identification, with the serial number of each component.

2. Equipment function, operating characteristics and limiting conditions.
  3. Performance curves, Engineering data and tests.
  4. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
1. Start-up procedures.
  2. Equipment or system break-in procedures.
  3. Routine and normal operating instructions.
  4. Regulation and control procedures.
  5. Instructions on stopping.
  6. Normal shutdown instructions.
  7. Seasonal and weekend operating instructions.
  8. Required sequences for electric or electronic systems.
  9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram the controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.
- F. Condensed Operating Instructions: Condensed instructions for start-up, shut-down, emergency operation, safety precautions, unusual features, and troubleshooting instructions. In addition to including a copy in the Operation and Maintenance Manual, permanently secure a laminated copy adjacent to the equipment, where the copy can be easily read by operating personnel.
- G. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include the responsibilities of the Authority's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- H. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping
  2. Shutdown instructions for each type of emergency
  3. Operating instructions for conditions outside normal operating limits
  4. Required sequences for electric or electronic systems
  5. Special operating instructions and procedures

## 2.04 PRODUCT MAINTENANCE MANUAL CONTENT

- A. Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. List each product included in the manual, identified by product name and arranged to match the manual's table of contents. For each product, list:
  - 1. Name
  - 2. Address
  - 3. Telephone number of the Installer or supplier and the maintenance service agent
  - 4. Cross-reference the Specification Section number and title in the Project manual and drawing or schedule designation or identifier (where applicable).
- C. Data may be taken directly from manufacturer's standard catalogs. Information shall be edited or marked to show only conditions pertinent to this Contract.
- D. Product Information: Include the following, as applicable:
  - 1. Product name and model number
  - 2. Manufacturer's name
  - 3. Color, pattern, and texture
  - 4. Material and chemical composition
  - 5. Reordering information for specially manufactured products
- E. Maintenance Procedures: Include the manufacturer's written recommendations, as well as the following:
  - 1. Inspection procedures
  - 2. Types of cleaning agents to be used, and methods of cleaning
  - 3. A list of cleaning agents and methods of cleaning that could be detrimental to the product
  - 4. The schedule for servicing, lubrication, routine cleaning and maintenance
  - 5. Repair instructions
- F. Repair Materials and Sources: Manufacturer's recommended special maintenance tools and list of spare parts and recommended stock quantities for one year of routine maintenance. Include lists of materials and local sources of materials and related services.

- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect the validity of warranties or bonds. Include the procedures to follow and the notifications required for warranty claims.

## 2.05 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL CONTENT

- A. List each system, subsystem, and piece of equipment not part of a system, included in the manual, identified by product name and arranged to match the manual's table of contents. Include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, a spare parts list, maintenance service contracts, and warranty and bond information, as described below. For each product list:
1. Name
  2. Address
  3. Telephone number of the Installer or supplier and the maintenance service agent, and cross-reference the Specification Section number and title in the Project manual and drawing or schedule designation or identifier where applicable.
- B. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins.
  2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly. If the system's control drawing is not adequate, provide simplified, professionally drawn, single line diagrams on minimum 8½-by-11 inch, 20-pound white bond paper.
  3. Identification and nomenclature of parts and components.
  4. A list of items recommended to be stocked as spare parts.
- C. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions
  2. Troubleshooting guide
  3. Precautions against improper maintenance
  4. Disassembly; component removal, repair, and replacement; and reassembly instructions
  5. Aligning, adjusting, and checking instructions
  6. Demonstration and training video recording, if available
  7. List of special tools required to service or maintain equipment



- D. Preventive Maintenance Instructions: Condensed excerpts from manufacturer's instructions for weekly, monthly, quarterly, annual, and other regularly scheduled maintenance prepared by a mechanical Subcontractor, with assistance from the equipment supplier.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, a list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
  - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
  - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Control Drawings: Include control drawings for equipment and components, including sequence of operations included in the control section of the Operation and Maintenance Manual submittal.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to the manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements, with the name and telephone number of the service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect the validity of warranties or bonds. Also include procedures to follow and required notifications for warranty claims.

### **PART 3 - EXECUTION (NOT USED)**

### **PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 78 23**

## SECTION 01 78 36

### WARRANTIES AND GUARANTEES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes administrative and procedural requirements for all warranties and guarantees necessary for Contract closeout.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 33 00, Submittal Procedures
- B. Section 01 60 00, Product Requirements
- C. Section 01 77 00, Substantial Completion

##### 1.03 SUBMITTAL OF WARRANTIES AND GUARANTEES

- A. Compile digital files (PDF) of each required warranty and guarantee properly executed by the Contractor, or by the Contractor and Subcontractor, Supplier, or manufacturer. Collect and assemble all warranties and guarantees into PDF format and provide to SCRRA for final review and acceptance. Prior to submission, verify that documents are in proper form, contain all required information, and are properly signed.
- B. Organize the warranty documents into an orderly sequence based on the table of contents of the Specifications and CSI Master Format 04 and the table of contents of the Project manual.
  - 1. Warranty Electronic File: Scan warranties and bonds and assemble the complete warranty and bond submittal package into a single indexed electronic PDF file, with links enabling navigation to each item. Provide a bookmarked table of contents at the beginning of the document.
- C. Special Project Warranty and Manufacturer's Guarantee Forms: Forms for Special Project warranties and for manufacturer's guarantees are included at the end of this Section. Prepare document utilizing the appropriate form, ready for execution by the Contractor or the Contractor and Subcontractor, Supplier, or manufacturer. Submit a draft to the Authority through the Engineer for approval prior to final execution.
  - 1. Refer to Specifications for specific content requirements and particular requirements for submittal of special Project warranties.
  - 2. Prepare standard product warranties and product guarantees, excepting manufacturer's standard printed warranties and guarantees, on the Contractor's, Subcontractor's, Material Supplier's, or manufacturer's own letterhead, and addressed to the Authority.

3. Warranty and guarantee letters shall be signed by all responsible parties, and by the Contractor in every case, with modifications only as approved by the Authority to suit the conditions pertaining to the warranty or guarantee.
- D. Manufacturer's Guarantee Forms: Manufacturer's guarantee forms may be used in lieu of special Project forms included at the end of the Section. Manufacturer's guarantee forms shall contain appropriate terms and identification, ready for execution by the required parties.
1. If proposed terms and conditions restrict guarantee coverage or require actions by the Authority beyond those specified, submit a draft of the guarantee to the Authority through the Engineer for review and acceptance before performance of the Work.
  2. In other cases, submit a draft of the guarantee to the Authority for approval prior to final execution of the guarantee.
- E. Signatures: The warranty and guarantee documents should be signed by persons authorized to sign warranties and guarantees, on behalf of the entity providing the warranty or guarantee. The Contractor shall co-sign all warranties, except the manufacturers' printed guarantees.

#### **1.04 TIME OF WARRANTY AND GUARANTEE SUBMITTALS**

- A. Time of Submittal: Submit written warranties on request of the Authority for designated portions of the Work where commencement of warranties on other than the date of Substantial Completion is indicated, or when delay in submittal of warranties might limit the Authority's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by the Authority during the construction period by separate agreement with the Contractor.
- C. Preliminary Submittal: Unless otherwise specified, obtain preliminary copies of warranties and guarantees within 14 days of completion of an applicable item of Work. Prepare and submit preliminary copies for review as specified herein.
- D. Final Submittal: Submit fully executed copies of warranties and guarantees within seven days of the date of Substantial Completion, but not later than three days prior to the date of application for final payment.
- E. Date of Warranties and Guarantees: Unless otherwise directed, the commencement date for warranty and guarantee periods shall be the date of Substantial Completion and acceptance of such Work. For warranties for Work accepted before or after the date of Substantial Completion such as beneficial occupancy, the commencement date will be the date of acceptance of such Work.

## 1.05 WARRANTIES AND GUARANTEES

- A. All warranties and manufacturer's guarantees shall name SCRRA as the beneficiary. For equipment, products, or components thereof bearing a manufacturer's warranty of guarantee that extends for a period of time beyond the Contractor's warranty and guarantee, so state in the warranty or guarantee.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties shall not relieve the Contractor of warranty on the Work that incorporates the products, nor shall they relieve suppliers, manufacturers, and installers required to countersign special warranties with the Contractor.
- C. Related Damages and Losses: When correcting warranted Work that has been found defective, remove and replace other Work that has been damaged as a result of such defect or that must be removed and replaced to provide access for correction of the warranted Work.
- D. Reinstatement of Warranty: When Work covered by a warranty has been found defective and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty, with an equitable adjustment for depreciation.
- E. Replacement Cost: Upon determination that Work covered by a warranty has been found to be defective, replace or reconstruct the Work to a condition acceptable to the Authority, complying with applicable requirements of the Contract Documents. The Contractor shall be responsible for all costs for replacing or reconstructing defective Work, regardless of whether the Authority has benefited from use of the Work through a portion of its anticipated useful service life.
- F. Recourse: Written warranties made to the Authority are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under law; nor shall warranty periods be interpreted as limitations on time in which the Authority can enforce such other duties, obligation, rights, or remedies.
- G. Rejection of Warranties: The Authority reserves the right to reject warranties and disallow the use of products with warranties in conflict with Contract Document requirements.
- H. Warranty as Condition of Acceptance: The Authority reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required until evidence is presented that those required to countersign such commitments are willing to do so.

### PART 2 - PRODUCTS (NOT USED)

### PART 3 - EXECUTION (NOT USED)

### PART 4 - MEASUREMENT AND PAYMENT

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 78 36**

## SECTION 01 78 39

### PROJECT RECORD DOCUMENTS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section addresses administrative and procedural requirements for preparing project As-Built drawings, specifications, product data and other miscellaneous documents submitted as required by the Contract.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 33 00, Submittal Procedures
- B. Section 01 77 00, Substantial Completion
- C. Section 01 77 19, Project Closeout

#### PART 2 - PRODUCTS

##### 2.01 AS-BUILT DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
  - 1. Preparation: Mark record prints digitally on PDF to show the actual installation where installation varies from that shown originally. Require the individual or entity who obtained the record data, whether the individual or entity is an Installer, Subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints as follows:
    - a. Provide complete information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an acceptable drawing technique.
    - c. Record data as soon as possible after obtaining it.
    - d. Record and check the markup before enclosing concealed installations.
    - e. Cross-reference record prints to corresponding archive photographic documentation.
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:

- a. Dimensional changes and revisions to details shown on Drawings. The lines shall be located on the drawings dimensionally from a fixed point, such as a street-curb line, centerline, permanent structure, or an exposed part of a structure.
  - b. Depths of foundations below first floor
  - c. Locations and depths of underground utilities including horizontal and vertical location of underground utilities affected by the Work. This includes new utilities installed and utilities found and left in place.
  - d. Revisions to routing of piping and conduits
  - e. Revisions to electrical circuitry
  - f. Actual equipment locations, duct size and routing
  - g. Changes made by Change Order or Change Directive
  - h. Changes made following the Authority's written orders
  - i. Details not on the original Contract Drawings
  - j. Field records for variable and concealed conditions
  - k. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up prints. Record new information and details that are recognized to be of importance to the Authority, but that were not shown on either the Contract Drawings or on shop drawings. Record changes on whichever drawing is most capable of showing the "field" condition fully and accurately; and when shop drawings are used for As-Built drawings.
  4. Mark the As-Built set digitally with red line annotation on the PDF. Use other colors to distinguish between changes for different categories of the Work at same location.
  5. Mark important additional information that was either shown schematically or omitted from the original Drawings.
  6. Note Construction Change Directive numbers, RFI numbers, option numbers, Change Order numbers, and similar identification, where applicable.
  7. Each drawing sheet, marked or unmarked, shall be stamped "As-Built" in red ink.
  8. As-Built drawings shall require approval by the Resident Engineer.

9. As-Built Drawings: Submit two complete sets of marked-up record prints and a complete PDF electronic file. Include each drawing, whether or not changes and additional information were recorded.

## **2.02 AS-BUILT SPECIFICATIONS**

- A. Preparation: Mark Specifications to indicate the actual product installation whenever the installation varies from that indicated in Specifications, addenda, and contract modifications.
  1. Provide detailed information on concealed products and equipment installations that cannot be readily identified and recorded later.
  2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
  3. Record the name of the manufacturer, supplier, and Installer, and include other information necessary to provide a record of the selections made.
  4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
  5. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit As-Built Specifications as paper copy and scanned PDF electronic files of the marked-up paper copy of the Specifications.

## **2.03 AS-BUILT CONSTRUCTION SCHEDULE**

The most current approved construction schedule shall be marked by red line annotation on the PDF showing all deviations occurring since the schedule was approved. Submit the final "As-Built" Project Schedule as paper copy and a scanned PDF electronic file of the marked-up paper copy of the final Project Schedule.

## **2.04 RECORD PRODUCT DATA**

- A. Preparation: Mark Product Data to indicate the actual product installation whenever the installation varies substantially from that indicated in the Product Data submittal.
  1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Include significant changes in the product delivered to the Project site, and changes in the manufacturer's written instructions for installation.
  3. Note related Change Orders, record Specifications, and record Drawings where applicable.



- B. Format: Submit record Product Data as paper copy and scanned PDF electronic file(s) of the marked-up paper copy of the Product Data. Include a record Product Data directory organized by Specification Section number and title, electronically linked to each item of the record Product Data.

## **2.05 MISCELLANEOUS RECORD SUBMITTALS**

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as paper copy and scanned PDF electronic file(s) of marked-up miscellaneous record submittals. Include a miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of the miscellaneous record submittals.

## **2.06 SUBMITTAL TITLE**

Label each document "PROJECT AS-BUILT" in two-inch-high printed letters or a height appropriate to document.

## **PART 3 - EXECUTION**

### **3.01 RECORDING AND MAINTENANCE**

- A. The monthly progress payment application will not be processed by the Authority until the Contractor is found by the Authority to have completely and accurately recorded all as-built information for Work performed through the period of the progress payment application.
- B. Store any non-digital record documents and Samples in the field office. Provide access to As-Built documents for the Authority's reference.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 BASIS OF PAYMENT**

- A. Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section. As-Built drawings and photographs will be reviewed each month and the monthly progress payment will only be approved and processed if the Contractor is found by the Authority to be in conformance with the requirements of this Section.
- B. If the Contractor does not provide both the As-Built Summary and Record Documents for Authority review, the Contractor's final pay request or other applicable progress payment request may be withheld until proper as-built and record documents are provided.

**END OF SECTION 01 78 39**

## SECTION 01 79 00

### DEMONSTRATION AND TRAINING

#### PART 1 - GENERAL

##### 1.01 SUMMARY

This Section includes administrative and procedural requirements for instructing the Authority's personnel, including the following:

- A. Demonstration of the operation of systems, subsystems, and equipment
- B. Training in operation and maintenance of systems, subsystems, and equipment
- C. Demonstration and training video recordings

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 31 00, Project Management and Coordination
- B. Section 01 78 23, Operations and Maintenance Data

##### 1.03 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit an outline of the instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
- B. Indicate the proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of a live instructional module.
- C. Qualification Data for instructor and videographer (See Quality Assurance Subsection 1.5, below).
- D. Attendance Record: For each training module, submit a list of participants and the length of the instruction time.
- E. Evaluations: For each participant and for each training module, submit the results and documentation of a performance-based test.

##### 1.04 CLOSEOUT SUBMITTALS

Demonstration and Training Video Recordings: Submit the recordings within seven days of the end of each training module.

- A. Identification: label with the following information:
  - 1. Name of Project

2. Name and address of the videographer
  3. Name of the Engineer
  4. Name of the Construction Manager
  5. Name of the Contractor
  6. Date of the video recording
- B. Transcript: Prepared in PDF electronic format. Include a cover sheet with the same label information as the corresponding video recording, and a table of contents with links to corresponding training components. Include the name of the Project and the date of the video recording on each page.
- C. Training Manuals: At the completion of training, submit complete training manual(s) for Authority's use, submit in PDF electronic file format.

### **1.05 QUALITY ASSURANCE**

- A. Instructor Qualifications: A factory-authorized service representative, experienced in operation and maintenance procedures and training.
- B. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.

### **1.06 COORDINATION**

- A. Pre-instruction Conference: Conduct the conference at the Project site to review methods and procedures related to the demonstration and training, including, but not limited to, the following:
1. Inspect and discuss locations and other facilities required for instruction.
  2. To avoid delays, review and finalize the instruction schedule and verify the availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed.
  3. Review the required content of instruction.
  4. When instruction must occur outside, review weather and forecasted weather conditions and procedures to determine suitable conditions.
- B. Coordinate instructors, providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate the content of training modules with content of approved emergency, operation and maintenance manuals. Do not submit the instruction program until the operation and maintenance data has been reviewed and approved by the Authority.

**PART 2 - PRODUCTS****2.01 INSTRUCTION PROGRAM**

- A. Program Structure: The Contractor shall develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections. Instruction programs shall be included for, but not limited to, the following systems with minimum instructional program times as stated below:
1. Motorized doors, including overhead coiling doors, overhead coiling grilles and automatic entrance doors: 4 hours each
  2. Equipment, including but not limited to loading dock equipment and waste compactors: 2 hours each
  3. Fire-protection systems, including fire alarm fire pumps and fire-extinguishing systems: 8 hours each
  4. Smoke control system: 4 hours
  5. Intrusion detection systems: 4 hours
  6. Access control systems: 8 hours
  7. Conveying systems, including elevators, wheelchair lifts, and escalators: 12 hours each
  8. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices: 4 hours each
  9. HVAC instrumentation and controls: 24 hours
  10. Building automation systems and related material, including sequences of operation: 40 hours
  11. Electrical service and distribution, including transformers, switchboards, panel boards, uninterruptible power supplies, and motor controls: 4 hours each
  12. Packaged engine generators, including transfer switches: 8 hours
  13. Lighting equipment and controls: 12 hours
  14. Communication systems, including intercommunication, surveillance, clocks and programming, voice and data and television equipment: 12 hours each
  15. Exterior maintenance systems, including irrigation systems: 4 hours

- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
1. Basis of system design, operational requirements, and criteria – Include the following:
    - a. System, subsystem, and equipment descriptions
    - b. Performance and design criteria if the Contractor is delegated design responsibility
    - c. Operating standards
    - d. Regulatory requirements
    - e. Equipment function
    - f. Operating characteristics
    - g. Limiting conditions
    - h. Performance curves
  2. Documentation: Review the following items in detail:
    - a. Emergency manuals
    - b. Operations manuals
    - c. Maintenance manuals
    - d. Project record documents
    - e. Identification systems
    - f. Warranties and bonds
    - g. Maintenance service agreements and similar continuing commitments
  3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages
    - b. Instructions on stopping
    - c. Shutdown instructions for each type of emergency
    - d. Operating instructions for conditions outside of normal operating limits

- e. Sequences for electric or electronic systems
  - f. Special operating instructions and procedures
4. Operations: Include the following, as applicable:
- a. Startup procedures
  - b. Equipment or system break-in procedures
  - c. Routine and normal operating instructions
  - d. Regulation and control procedures
  - e. Control sequences
  - f. Safety procedures
  - g. Instructions on stopping
  - h. Normal shutdown instructions
  - i. Operating procedures for emergencies
  - j. Operating procedures for system, subsystem, or equipment failure
  - k. Seasonal and weekend operating instructions
  - l. Required sequences for electric or electronic systems
  - m. Special operating instructions and procedures
  - n. Noise and vibration adjustments
  - o. Economy and efficiency adjustments
  - p. Effective energy utilization
5. Adjustments: Include the following:
- a. Alignments
  - b. Checking adjustments
  - c. Noise and vibration adjustments
  - d. Economy and efficiency adjustments
6. Troubleshooting: Include the following:
- a. Diagnostic instructions
  - b. Test and inspection procedures

7. Maintenance: Include the following:
  - a. Inspection procedures
  - b. Types of cleaning agents to be used, and methods of cleaning
  - c. List of cleaning agents and methods of cleaning that are detrimental to product
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance
  - f. Procedures for routine maintenance
  - g. Instruction on use of special tools
8. Repairs: Include the following:
  - a. Diagnosis instructions
  - b. Repair instructions
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions
  - d. Instructions for identifying parts and components
  - e. Review of spare parts needed for operation and maintenance

### **PART 3 - EXECUTION**

#### **3.01 PREPARATION**

Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23, Operations and Maintenance Data.

#### **3.02 INSTRUCTION**

- A. Facilitator: Engage a qualified facilitator to prepare the instruction program and training modules, to coordinate instructors, and to coordinate between the Contractor and the Authority for the number of participants, instruction times, and location.
- B. Provide manufacturer's instructors or instructors certified by the manufacturer as being experienced in operation and maintenance procedures for each system, subsystem, or piece of equipment to instruct the Authority's personnel on how to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. The Authority will provide the instructor to the basis of system design, operational requirements, criteria, and regulatory requirements.
  2. The Authority will provide the instructor a description the Authority's operational philosophy.
  3. The Authority will provide the Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
1. Schedule training with the Authority with at least seven days advance notice.
  2. Schedule training to conform to personnel availability at the Site, and to conclude prior to the start-up of system.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility, using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At the conclusion of each training module, assess and document each participant's mastery of the module by use of an oral, written, or demonstration performance-based test.
- F. In addition to written technical descriptions, training shall detail the training program itself to allow those who have completed training to provide training for new employees, resulting in a self-perpetuating training program.
- G. Cleanup: Collect used and leftover educational materials and deliver to the Authority. Remove instructional equipment. Restore systems and equipment to the condition existing before initial training use.

### **3.03 DEMONSTRATION AND TRAINING VIDEO RECORDINGS**

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
1. At the beginning of each training module, record each chart containing the learning objective and the lesson outline.
  2. Video shall allow self-training, so future employees may view it at their own convenience and be able to comprehend the system without needing to have an instructor in attendance.
- B. Video: Provide minimum 1280 x 720 video resolution converted to a format file type acceptable to the Authority, on electronic media.



1. Electronic Media: Format digital video acceptable to the Authority, with a commercial-grade graphic label.
  2. File Hierarchy: Organize the folder structure and file locations according to the Project manual table of contents. Provide a complete screen-based menu.
  3. File Names: Utilize file names based on the name of the equipment generally described in the video segment, as identified in Project Specifications.
  4. The Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training video that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:
    - a. Name of the Contractor/Installer
    - b. Business address
    - c. Business phone number
    - d. Point of contact
    - e. E-mail address
- C. Recording: Mount the camera on a tripod before starting recording, unless otherwise necessary to adequately cover the area of demonstration and training. Display continuous running time. Film training session(s) in segments not to exceed 15 minutes.
1. Produce segments to present a single significant piece of equipment per segment.
  2. Organize segments with multiple pieces of equipment to follow the order of the Project manual table of contents.
  3. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause the training session. Begin the training session again upon commencement of a new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording. Furnish additional portable lighting as required.
1. Narration: Describe scenes on the video recording by audio narration using a microphone while the video is recorded. Include a description of the items being viewed.
  2. Transcript: Provide a transcript of the narration. Display images and running time captured from the video opposite the corresponding narration segment.

3. Pre-produced Video Recordings: Provide video recordings used as a component of training modules in the same format as recordings of live training.

**PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 79 00**

## SECTION 01 91 13

### GENERAL COMMISSIONING REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

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. This Section includes general requirements that apply to implementation of commissioning for systems, assemblies, or components. Authority will require the Contractor to perform facility commissioning for the purpose of verifying compliance of the project to the requirements of the contract along with any amendments approved by Authority during the construction process. The Contractor shall be 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 sub-systems as required by the Commissioning Plan.

##### 1.02 RELATED SECTIONS

- A. Section 01 77 00, Substantial Completion
- B. Section 01 78 23, Operation and Maintenance Data

##### 1.03 SCRRA'S RESPONSIBILITIES

Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

##### 1.04 CONTRACTOR'S RESPONSIBILITIES

The Contractor shall 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:

- A. Evaluate performance deficiencies identified in test reports and, in collaboration with the entity responsible for system and equipment installation, recommend corrective action.
- B. Resolve issues recorded in the test reports.
- C. Organize and lead the commissioning team and convene the commissioning team meetings held on a weekly basis. Integrate and coordinate commissioning process activities with the construction schedule.
- D. Review and complete construction checklists as provided by the Authority and as Work is completed, and provide them to the Authority on a daily basis.
- E. Complete commissioning process test procedures including specific construction checklists and commissioning process test procedures.

- F. Witness systems, assemblies, equipment, and component start-up. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.
- G. Verify the execution of commissioning process activities, using random sampling. The sampling rate may vary from 1 to 10 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the Contractor will report the failure to the Authority.

#### **1.05 START-UP, TEST AND ADJUST AND BALANCING**

The Contractor shall have completed all start-up procedures and testing, all adjusting and balancing required for all of the component systems and all systems and sub-systems shall be fully functional and operating in normal operational mode before the commissioning plan is implemented and completed. This includes the complete installation of all equipment, materials, controls, etc. per the contract, scoping documents and related directives, clarifications, approved changes, etc.

#### **1.06 COMMISSIONING PLAN**

The Commissioning Plan will be developed by the Contractor to complete the commissioning in conformance the contract. The Commissioning Plan will be developed prior to completion of the installation. The Contractor is obligated to provide all necessary information pertaining to the actual equipment and installation necessary to prepare the Commissioning Plan. If Contractor initiated system changes have been made that alters the commissioning process, the Contractor will notify the Engineers of record and the Authority. The Commissioning Plan will include the following:

- A. The purpose of the commissioning
- B. Detail of the commissioning process
- C. Commissioning team members' responsibilities
- D. Describe Pre-functional Construction Checklist Procedures
- E. Provide a guideline for acceptance of each piece of equipment or system
- F. Systems to be commissioned

#### **1.07 WORK TO RESOLVE DEFICIENCIES**

In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet the original design intent. Correction of work will be completed under direction of the design professional, with input from the Contractor, equipment supplier and Authority.

### **1.08 ADDITIONAL COMMISSIONING**

Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The Contractor, Subcontractors, and equipment suppliers shall include a reasonable reserve to complete this work as part of their contractual obligations.

Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process. Experimentation to render system performance will be permitted. If Authority deems the experimentation work to be ineffective or untimely to the commissioning process, Authority will notify the Contractor indicating the nature of the problem, expected steps to be taken and the deadline for completion of activities. If the deadline passes without resolution of the problem, Authority reserves the right to obtain supplementary services and equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the sole responsibility of the Contractor.

### **1.09 COMMISSIONING FIELD BOOK**

The Commissioning Field Book will be created by the Contractor to identify and track all pertinent commissioning documentation required during the installation start-up, check-out and commissioning phases. The Field Book will be managed and maintained by the Contractor in digital format and will be made available to all subcontractors for their use. The Field Book provides a central location for the subcontractors and Authority to identify, copy, and organize all pertinent information. The Field Book will at a minimum include the following format:

- A. Summary describing the Field Book contents and use.
- B. Commissioning Plan for contractor field reference.
- C. Listing of all specification documentation requirements listed by specification section, with construction completion sign offs for appropriate parties. These types of documents include piping pressure testing, flushing reports, electrical circuit tests, factory start-up reports and any field testing relative to the project.
- D. Tabs for each specification section with copies of pre-functional and functional test check sheets provided by coordination of subcontractors and Authority for Contractor completion and space for related contractor-supplied documents.
- E. Commissioning project reports, resolution logs schedule information or any other documentation.

### **1.10 PRE-FUNCTIONAL CONSTRUCTION CHECKLISTS**

Using the Pre-functional Construction Checklists, the Contractor must verify that the systems installed are in compliance with the Construction Documents and are fully functional. Commissioning is not intended to be a testing or inspection function that replaces any of the Contractor's or subcontractors' obligations for testing and proof of performance. Functional testing will only begin when checklists are completed by the appropriate subcontractors, initialed, signed and returned to the Contractor.

**1.11 FUNCTIONAL TESTING**

Functional testing is performed by experienced and qualified technicians of the Contractors and subcontractor(s), responsible for installation as facilitated and supervised by the Contractor and may be observed by Authority. Functional testing will verify proper sequencing, operation and performance of installed equipment and systems under realistic operating conditions. The functional testing will follow with written Functional Test Procedures with test results documented for permanent record.

**1.12 DOCUMENTATION**

In addition to the Pre-functional Construction Checklists and Functional Test Procedures, written documentation will be maintained for all other commissioning activities. Project communication reports shall be issued by the Contractor to Authority to document apparent deficiencies identified during examination of design and construction documents, daily activities on-site, construction deficiencies and successful or unsuccessful functional test results. At the end of the commissioning process, all documentation will be assembled and summarized in the Final Commissioning Report.

**1.13 DEFICIENCY RESOLUTION**

When a Project Report is issued to address an identified deficiency, the Contractor shall forward the reports to the appropriate parties to initiate corrective action in an expeditious manner. The Engineers of Record are relied on for supplemental instructions or design modifications and issuance of final design details and the Contractor, subcontractors and equipment suppliers are relied on for implementation of that design.

**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION (NOT USED)****PART 4 - MEASUREMENT AND PAYMENT**

Work of this Section is considered incidental to Work under other payment items and no separate measurement or payment will be made to the Contractor for Work of this Section.

**END OF SECTION 01 91 13**

**SECTION 03 21 00**  
**REINFORCING STEEL**

**PART 1 - GENERAL**

**1.1 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

**1.2 REFERENCES**

- A. American Concrete Institute (ACI):
  - 1. SP 66, ACI Detailing Manual.
  - 2. 318, Building Code Requirements for Structural Concrete.
- B. ASTM International (ASTM):
  - 1. A1022, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
  - 2. A1022, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
  - 3. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
  - 4. A706, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
- C. American Welding Society (AWS):
  - 1. D1.4, Structural Welding Code – Steel Reinforcing Bars.
- D. Concrete Reinforcing Steel Institute (CRSI):
  - 1. Manual of Standard Practice.
- E. Current California Department of Transportation Standard Specifications Current or Latest Edition.

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

### 1.3 SUBMITTALS

- A. Shop Drawings:
  - 1. See Section 01 33 00 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. All mechanical splices
  - 8. Locations where proprietary rebar mechanical splices are required or proposed for use.
  - 9. 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.

### 1.4 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.

### **1.5 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**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable, or approved equivalent as a comparable product:
  1. Rebar adhesive anchors:
    - a. HIT-HY200 System by HILTI FASTENING SYSTEMS, INC.
    - b. Red Head Adhesive Anchoring Systems
    - c. Pure 110+ by Dewalt
  2. Rebar mechanical splices:
    - a. nVent 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.

## 2.2 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.
  - 3. Meet requirements of Annex A1 of ASTM A775.
  - 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.

## 2.3 ACCESSORIES

- A. Metal Chairs, Runners, Bolsters, Spacers, Hangers, and Other Rebar Supports:
  - 1. Plastic-coated tips in contact with forms.
  - 2. Plastic coating meeting requirements of CRSI Manual of Standard Practice.
- B. Protective plastic caps at mechanical splices.

## 2.4 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**

### **3.1 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 11/2 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, unless indicated otherwise on Plans:
  - 1. Three (3) inches for concrete cast against earth, 2 inches all other locations.
- C. 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. Submit in accordance with 01 33 00 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.
- D. 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 preproduction 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.
      - d) The Welding Procedure Specification (WPS) for resistance welding.
      - 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.

E. 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 inch.



- a. Place spacer rebars at 3 feet maximum centers to maintain the required 1 inch 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.

### **3.2 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**

### **4.1 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.

### **4.2 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.

**END OF SECTION 03 21 00**

**SECTION 03 31 00**  
**STRUCTURAL CONCRETE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Cast-in-place concrete and grout.
- 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.
  - 4. 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
  - 5. 304.2R, Placing Concrete by Pumping Methods.
  - 6. 305R, Hot Weather Concreting.
  - 7. 306R, Cold Weather Concreting.
  - 8. 318, Building Code Requirements for Structural Concrete.
  - 9. 347R, Recommended Practice for Concrete Formwork.
- C. ASTM International (ASTM):

1. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. C33, Standard Specification for Concrete Aggregates.
3. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. C94, Standard Specification for Ready-Mixed Concrete.
5. C138, Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
6. C143, Standard Test Method for Slump of Hydraulic Cement Concrete.
7. C150, Standard Specification for Portland Cement.
8. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
9. C172, Standard Practice for Sampling Freshly Mixed Concrete.
10. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
12. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
13. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
14. C494, Standard Specification for Chemical Admixtures for Concrete.
15. C578, standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
16. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
17. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Testing Agency Evaluation.
18. C1240, Standard Specification for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout.
19. C1260, Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Mortar-Bar Method).

20. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
  21. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
  22. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
  23. E329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- D. Corps of Engineers (COE):
1. CRD-C621, Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Nonshrink).
- E. Standard Specifications for Public Works Construction, SSPWC Latest or Current Edition.

### 1.03 DEFINITIONS

- A. Per ACI 116R except as modified herein:
1. Concrete fill: Non-structural concrete.
  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.
  4. Indicated: Indicated by Contract Documents.
  5. Nonexposed concrete: Not exposed to view after construction is complete.
  6. Required: Required by Contract Documents.
  7. Specified strength: Specified compressive strength at 28 days.
  8. Submitted: Submitted to Engineer.

### 1.04 SUBMITTALS

- A. Shop Drawings:
1. See Section 01 33 00 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) Location of use
  - 2) Plan sheets showing work
  - 3) Target strength
  - 4) Sieve analysis and source of fine and coarse aggregates.
  - 5) Test for aggregate organic impurities.
  - 6) Test for deleterious aggregate per ASTM C289.
  - 7) Proportioning of all materials.
  - 8) Type of cement with mill certificate for cement.
  - 9) Type of fly ash with certificate of conformance to Specification requirements.
  - 10) Slump.
  - 11) Air content.
  - 12) Brand, type, ACI or ASTM designation, and quantity of each admixture proposed for use.
  - 13) 28-day cylinder compressive test results of trial mixes per ACI 318 and as indicated herein.
  - 14) Shrinkage test results.
  - 15) 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.
  - 6) Color if used and type.
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 moisture-proof, weather-tight 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, or approved equivalent as a comparable product:
1. Nonshrink, nonmetallic grout:
    - a. Sika "SikaGrout 212."
    - b. Euclid Chemical "NS Grout."
    - c. Master Builders Solutions. "Masterflow 713."
  2. Epoxy grout:
    - a. BASF Admixtures, Inc. "Brutem MPG."
    - b. Euclid Chemical Company, "E3-G."
    - c. Fosroc, "Conbextra HF".
  3. Expansion joint fillers:
    - a. .
    - 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. Master Builders Solutions Admixtures US LLC
    - c. L & M Construction Chemicals Inc.
  7. Calcium nitrate:
    - a. gcp applied technologies
      - 1) DCI.
      - 2) DCI'S.
    - b. Euclid Chemical Company.
      - 1) Eucon BCN.
      - 2) Eucon CIA.
  8. Microsilica (Silica Fume):
    - a. gcp applied technologies "Force 10,000 D".
    - b. Euclid Chemical Company "Eucon MSA".
- B. Submit request for substitutions in accordance with Section 01 25 00.

## 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/](http://www.dot.ca.gov/hq/esc/approved_products_list/)
- C. Admixtures:

1. Air entraining admixtures: ASTM C260.
  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.
  7. Microsilica: ASTM C1240.
  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 feet by 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.
  - 4. Chamfer strips: Clear white pine, surface against concrete planed.
  - 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 inches 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. L & M Construction Chemicals "Everbond."
  - 4. Master Builders Solutions "MasterEmaco A660"
- 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	Concrete Class*	Maximum Slump (Inches)
<b>Street Surface Improvements</b>		
Concrete Pavement (not integral with curb)	565-C-3250	4"
Curb, Integral Curb and Pavement, Gutter, Walk, Alley Aprons, Extruded Curb & Gutter	565-C-3250	4"

<b>Sewer and Storm Drainage Facilities</b>		
Pipe Collars, Beam Support for Pipe, Pre-Cast Manhole Components, Catch Basins, Sidewalk Culverts	565-C-3250	4"
Pipe Bedding and Encasement, Anchors and Thrust Blocks, Wall Support for Pipe	520-C-2500	4"
Tunnel and Trench Backfill	520-C-2500	4"
<b>Reinforced Structures</b>		
Bridges, Buildings, Retaining Walls	650-CW-4000	4"
Cast-In-Place Piles	650-CW-4000	4"
Channel and Boxes	650-CW-4000	4"
Walls and Deck	650-CW-4000	4"
<b>Miscellaneous</b>		
Street Light and Traffic Signal Foundations, Survey Monuments	565-C-3250	4"
Fence and Guard Post Foundations	565-C-3250	4"
Coarse Masonry Grout	610-E-2000G	10"

\*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:

<b>MAX AGGREGATE SIZE</b>	<b>TOTAL AIR CONTENT PERCENT</b>
1 inch or 3/4 inches	5 to 7

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:

SPECIFIED STRENGTH	MINIMUM CEMENT, LB/CY			MAXIMUM WATER CEMENT RATIO BY WEIGHT
	MAXIMUM AGGREGATE SIZE			
	1/2"	3/4"	1"	
4000	650	650	650	0.45

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 air.
  - 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 Saltwater 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  $\frac{3}{4}$ " chamfer strips in forms to produce  $\frac{3}{4}$ " 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  $\frac{1}{4}$ " 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:

<b>OUTDOOR TEMPERATURE AT PLACEMENT (IN SHADE)</b>	<b>CONCRETE TEMPERATURE AT MIXING</b>
Below 30° F	70° F
Between 30°-45° F	60° F
Above 45° F	50° F

- c. Do not place heated concrete that is warmer than 80° F.

- 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. SCRRA 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 SCRRA in obtaining and testing samples.
- B. Tests During Construction:
1. Strength test - procedure:
    - a. Three cylinders, 6 inches diameter 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:
    - a. Per ASTM C231, ASTM C173, and ASTM C138.
    - 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 SCRRA 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. The 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 03 31 00**

**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 are 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.
- B. CBC, California Building Code 2010.
- C. CRSI, Concrete Reinforcing Steel Institute.
- D. IBC, International Building Code 2009.
- 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.
  - 2. ASTM C150, Standard Specification for Portland Cement.

3. ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes.
  4. ASTM C270 Standard Specification for Mortar for Unit Masonry.
  5. ASTM C404, Standard Specification for Aggregates for Masonry Grout.
  6. ASTM C476, Standard Specification for Grout for Masonry.
  7. ASTM C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- G. Standard Specifications for Public Works Construction, Current or Latest Edition.

### **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 SCRRA 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 SCRRA for approval.

### **1.04 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 SCRRA), performs and sends required test results to:
    - a. The SCRRA 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 SCRRA Inspector will be constantly present during laying of reinforced masonry.
- G. All costs incurred for retests and re-inspections required because of failure of original tests will be charged to Contractor, and deducted from Contract price by Change Order.
- H. Should core testing be required by the Engineer, 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.
- C. Mortar: ASTM C161.
- D. Grout: ASTM C476.

- E. Hydrated Lime: ASTM C207, Type S.
  - 1. Kel-Crete may be substituted for lime, when approved by SCRRA.
- F. Admixture for Grout: Grout Air No. 2 use, as manufactured by Sika Chemical Corporation, must be approved by SCRRA, see Section 01 40 00 - Quality Requirements.
- G. Water: Potable and fresh.
- H. Cleaning Materials: Shure Klean No. 600 Detergent by Process Solvent Co. Inc.
- 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.
- B. Colored Mortar custom match samples shall be submitted for approval prior to construction.
- C. 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
- D. 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.



- E. 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. 1. Equipment for mixing and handling mortar and grout shall be acceptable to SCRRA.
  - 2. 2. Batches of less than one sack of cement, and fractional sack batches will not be permitted.
- F. 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. 1. Do not retemper mortar which has become hard or non-plastic.
  - 2. 2. Discard mortar which has not been used within one-hour after original mixing.
- G. 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 tothing 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 solid, 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 solid, 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 04 22 00**

## 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](http://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 1/4" 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**

- A. 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.
- B. Installation plan, including grading methods, placement of structural section courses, compaction methods, and edge treatments.
- C. Material samples of pavers showing the range of variation within the selected color(s) for approval by SCRRA, 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
  - 1. 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.
  - 2. 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.
  - 3. The Quality Control Plan shall contain at a minimum, but not limited to, the following elements:
    - a. The manufacturer's quality control procedures.
    - b. 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.
    - c. 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.
  - 1. Portland Cement: Conform to ASTM C150.
  - 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.
9. Pigment: Conforming to ASTM C979.
10. Color: Monochromatic colors [specify] or natural gray (no pigment).
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

- A. 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.

ASTM Sieve Size Percent Passing (by weight)

1/2 inch 100 – 100  
 3/8 inch 94 – 100  
 1/4 inch 39 – 94  
 No. 4 23 – 39  
 No. 8 8 – 23  
 No. 16 0 - 8

- B. Base Course Aggregate

The 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)

1-1/2 inch 100 – 100  
 1 inch 90 – 100  
 3/4 inch 48 – 90  
 1/2 inch 27 – 48  
 1/4 inch 12 – 27  
 No. 4 0 - 12

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**

- A. 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.
- B. 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**

- A. 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**

- A. 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  $\frac{1}{2}$ " from finish levels. The pavers shall be flush to  $\frac{1}{2}$ " above edge restraints. Additional void filler material shall be swept in the paver voids, as required, to within  $\frac{1}{2}$ " 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.

### **4.02 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 04 22 10**

**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: Standard Symbols for Welding, Brazing, and Non-Destructive Examination
  3. AISC Steel Construction Manual ASD – 9th Edition
  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
  6. Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation - Specifications for Structural Joints Using ASTM A325 Bolts.
  7. ASTM A36: Specification for Carbon Structural Steel
  8. Uniform Building Code – current or latest Edition

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00, 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
- D. 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
  2. Anchor bolts, nuts and washers: ASTM F1554.
- E. Paint primer: Specified in 09 90 00 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.
- F. Bolting: Use high-strength steel bolts (A 325, slip-critical, Class A) hot dipped galvanized. Conform to the latest edition of Specifications for Structural Joints Using ASTM A 325 or A 490 Bolts as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
- 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 or 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 SCRRA 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.

**END OF SECTION 05 12 23**

**SECTION 05 52 00**  
**HANDRAILS AND RAILINGS**

**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 (ROW) 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 01 33 00 - Submittal Procedures
  - 2. Section 05 12 23 - Structural Steel
  - 3. Section 09 90 00 - Painting and Coating

**1.02 REFERENCES**

- A. AWS D1.1: Structural Welding Code-Steel
- B. SSPWC: Standard specifications for Public Works Construction, Current Version
- C. CALTRANS: State of California Department of Transportation Standard Specifications Current Version
- 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. FF-S-92B: Federal Specification Screw, Machine, Slotted, Cross Recessed or Hexagon Head
- H. State of California, Department of Industrial Relations, Division of Occupational Safety and Health (CAL/OSHA): As applicable to railing
- I. Use finishes for stainless steel complying with "Metal Finishes Manual" by NAAMM.



- J. The sheet Work, except as otherwise indicated or specified, shall comply with “Architectural Sheet Metal Specifications” and “Architectural Sheet Metal Manual” by SMACNA.
- K. 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.
- B. Welding procedures and welder qualifications and welder registration as required by the American Welding Society.
  - 1. Manufacturer's product data for non-shrink, non-ferrous cement grout.
- C. Shop Drawings showing layout, locations, Sections, elevations, details, dimensions, finishes and installation details.
- D. Certified test reports, as required, for materials specified in Part 2 - Products.
- E. 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**

- A. 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**

- A. 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.
  - 1. Sheet – ASTM A167, ASTM A480, and AISI Type 302 or 304
  - 2. Plate – ASTM A167
  - 3. Bar Stock – ASTM A276
  - 4. Tubing – ASTM A269
  - 5. Castings – ASTM A296, iron-chromium, nickel
  - 6. 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.

- F. 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 Current Version 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 05 52 00**

**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 01 33 00 – Submittal Procedures
  - 2. Section 03 21 00 – Reinforcing Steel
  - 3. Section 03 31 00 Structural Concrete
  - 4. Section 09 90 00 - Painting and Coating
  - 5. Section 09 96 23 – Graffiti-Resistant Coating

**1.02 REFERENCES**

- A. SCRRRA Engineering Standards ES4002, Pedestrian Swing Gate Details.
  - 1. SSPWC: Standard Specifications for Public Works Construction Current or Latest Edition, Sections 201-1, Portland Cement Concrete, and 201-3, Expansion Joint Filler and Joint Sealants.
  - 2. AWS D1.1, Structural Welding Code

**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 and finish so that adjoining surfaces are flush and smooth.
  2. Fabricate the gravity gate hinge top and bottom sleeves 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 contact 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 not 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 per Section 09 96 23
- 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 by the Authority. 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 – Match existing or the following, whichever is greater. 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. Bicycle Traffic Control During Construction – Maintain bicycle traffic flow at all times during construction.
- I. Submittal Requirements - Submit a pedestrian and bicycle 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 05 52 10**

## **SECTION 05 53 00**

### **METAL GRATING**

#### **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 zincplated 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.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.
- 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.
  - 1. Material for Anchors in Interior Locations: Carbon steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5.
  - 2. Material for Anchors in Exterior Locations: Alloy Group 1 (A1) or 2 (A4) stainless-steel bolts complying with ASTM F593 (ASTM F738M) and nuts complying with ASTM F594 (ASTM F836M).
- 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**

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 05 53 00**



## 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 - Reinforcing Steel.
  - 2. Section 09 90 00 – Painting and Coatings

##### 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".
- B. AWS - American Welding Society: D-1.1, "Code for Welding in Construction"
- 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 by SSPWC.
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 05 55 00**

## 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 at Metrolink stations.
- B. Also included in this section are specifications for Directional Bar Tiles for platforms at Metrolink Stations

##### 1.02 REFERENCES

- A. ASTM International:
  - 1. B117 Practice for Operating Salt Spray (Fog) Apparatus
  - 2. C501 Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser
  - 3. D570 Test Method for Water Absorption of Plastics
  - 4. D638 Test Method for Tensile Properties of Plastics
  - 5. D695 Test Method for Compressive Properties of Rigid Plastics
  - 6. D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
  - 7. D1308 Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems.
  - 8. D5420 Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
  - 9. 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. FTA ADA Circular C4710.0-3.5 C Staggered Dome Pattern
- D. Caltrans, Permanent Pedestrian Facilities ADA Compliance Handbook
- E. 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.
  - a. Include procedures for containment and disposal of milling and saw cutting waste water if the cut in method is to be used for installation.
2. The Shop Drawings do not need to feature a full dimensional layout of the platform edges.
3. Platform Shop drawings shall depict the platform edge and end treatments.
4. Platform Shop drawings shall depict the placement and spacing of directional bars.
5. Pedestrian crossing shop drawings shall depict the area of crossing, showing dimension to handrail, edge of paving, or adjacent obstructions.

#### 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.
  - b. Truncated Dome Panel sample shall include longitudinal edge with integral flange and transverse ship-lap edge.
  - c. Directional Bar sample shall be a full size sample.
  - d. Samples of panels and sealant for verification of color match, samples shall be clearly labeled.
  - e. Upon approval sample(s) may be full sized and if undamaged, installed as part of the work.

#### 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.
- C. Contractor to demonstrate method of cutting groove to assure smooth, clean, and neat cut for panel flange.
- D. Detectable Warning Panel and Directional Bar Tile must be compliant with ADAAG, PROWAG, and California Title 24 Requirements.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Panel type shall be identified by part number on packages.
- B. Packages shall be stored in a manner that preserves the new condition of the panels.

#### **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, holes, 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 type, and corresponding fasteners or required adhesive. 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., a division of SureWex Inc., of Wilmington, 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, and Caltrans A88A.
  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(2.3 to 2.4 inches is acceptable).
    - 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. , per FTA ADA Circular C4710.0-3.5 C Staggered Dome Pattern.

- 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, (2.3 to 2.4 inches is acceptable).
  - c. In order to ensure a uniform appearance of the detectable warning surface throughout the transit system, equivalent or equal products with alternate patterns, colors or textures will not be acceptable.
  3. Truncated dome pattern shall align properly from panel to panel.
- E. Directional Bar Geometry
1. See item D 1 above
  2. Panel shall be 4 feet long by 3 feet wide, and consist of 3 rows of bars, containing 16 bars per row. See ES 3203.
  3. Directional bars shall be perpendicular to adjacent rail.
  4. Surface applied Directional Bar tile is preferred.
  5. Raised directional bars shall have the following measurements:
    - a. 0.20" height, plus or minus 0.01"
    - b. 11.0" length, plus or minus 0.3"
    - c. 1.3" base width, plus or minus 0.03"
    - d. 0.9" top width, plus or minus 0.02"
    - e. 3" on center bar spacing plus or minus 0.3"
- F. 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 Width 36-inch
      - 2) Length to match gate opening
      - 3) Minimum 7/16-inch thick deep flange along one long side.
      - 4) Panels with full perimeter flange are also acceptable.

- b. Platforms (Staggered Pattern):
  - 1) Nominal 24-inch x 48-inch
  - 2) Minimum 7/16-inch thick deep flange along one long side
  - 3) Upon approval panels with no flange may be used. Provide method of installation to align edge.

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.

G. 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.

H. Performance

- 1. Panels shall comply with the following performance characteristics:

Property	ASTM Test Method	Nominal Value
Salt Spray (200 Hours)	B117	No Change
Wear Resistance	C501	500 (Min.)
Slip Resistance	C1028	0.80 (Min.)
Water Absorption	D570	0.05% (Max.)
Tensile Strength	D638	19,000 psi (Min.)
Compressive Strength	D695	28,000 psi (Min.)
Flexural Strength	D790	25,000 psi (Min.)
Chemical Resistance	D1308	No Stain or Discoloration
Gardner Impact Test	D5420	550 in. lbf/in (Min.)
Accelerated Weathering (3000 Hours)	G155	Delta E: 4.5 (Max.)

## 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 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 09 61 50**

## 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. Division 05 - Metals
  - 4. 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
  - 3. SSPWC: Standard Specifications for Public Works Construction Current or Latest Edition

##### 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. No painting or coating will be accepted prior to approval of the color sample.

#### **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. Benzene, 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, allowing minimum two weeks for consideration before the material to be painted is to be ordered and 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 voids in the paint or coating coverage of any size.
- 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. Recoat 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.
- B. Protect all work until handover of the Work to SCRRA.

**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 09 90 00**

## SECTION 09 96 23

### GRAFFITI-RESISTANT COATING

#### 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 15 feet above finish grade or floor.
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 03 31 00
  - 2. Section 04 22 00
  - 3. Section 09 90 00

##### 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: 8.5 x 11 in. 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. Manufacturer's Instructions: Copies of the manufacturer's instructions for graffiti removal and maintenance.

##### 1.04 QUALITY ASSURANCE

- A. 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 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**

- A. Sacrificial: SC-1 or SC-1X by ProSoCo, or equal as approved by the Engineer.
- B. 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 09 96 23**

**SECTION 10 14 53**  
**ROADWAY SIGNAGE**

**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):
1. A36 (A36M) – Standard Specification for Carbon Structural Steel.
  2. A53 (A53M) – Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
  3. A123 (A123M) – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  4. A153 (A153M) – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
  5. A240 (A240M) – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
  6. A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.



7. A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
  8. A501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
  9. A666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
  10. A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
  11. B209 – Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
  12. B221 – Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  13. B429 (B429M) – Standard Specification for Aluminum Alloy Extruded Structural Pipe and Tube.
  14. B633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- C. American Welding Society (AWS):
1. D1.1 – Structural Welding Code – Steel.
- D. CE – U.S. Army Corps of Engineers:
1. CE CRD-C621 – Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Non-shrink).
- 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.
- F. Layout Drawings: Show sign layout at each location to assure all signs are readable and do not block and are not blocked by other safety lights, signs, or railroad or roadway equipment.

#### **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 or easily accessible.
  3. Provide concealed fasteners for interconnection of metal work components and for attachment to other work except where exposed fasteners are visible 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.
  - 1. Material: Tnemec-Zinc 90-97.
  - 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.
    - b. Keeler & Long, div. PPG Industries.
    - c. International Protective Coatings, Div. International Paint.
- 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 10 14 53**

## **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:
  - 1. All Work associated with constructing new and maintaining existing railroad signage along the right-of-way, including excavation for signposts.
  - 2. 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 SCRRA 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 SCRRRA Engineering Standards drawing for a specific sign.

2. Derail switch target signage shall conform to SCRRRA ES2610, Derailing Switch Target and ES2611, Derail Signs.
3. Derail switch notice signage shall conform to SCRRRA 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 SCRRRA ES2703, Color Indications of Targets and Lenses on Switch Stands.
6. Station train and locomotive position spot signs shall conform to SCRRRA ES3330-01 through ES3330-06.
7. Other station signs shall conform to SCRRRA ES3301 through ES3329.
8. Highway-railroad crossing crossbuck signs for public crossings shall conform to SCRRRA ES4101, Highway-Railroad Crossing Crossbuck Signs.
9. Private, pedestrian and bicycle railroad grade crossing signs shall conform to SCRRRA ES4102, Private, Pedestrian and Bicycle Railroad Grade Crossing Signs.
10. Private crossing closure notification sign shall conform to SCRRRA ES4312, Private Crossing Closure Notification Signs.
11. Construction project funding identification signs shall conform to SCRRRA ES5201, Construction Project Funding Identification Sign for locally and federally funded projects.
12. Sign post, anchors and fasteners shall conform to SCRRRA ES5210, Details for Installing Signs at Grade.
13. Milepost signs shall conform to SCRRRA ES5211, Milepost. Tenth mile post signs shall conform to SCRRRA ES5214, No Trespassing and Tenth Mile Post Sign.
14. Permanent speed restriction signs shall conform to SCRRRA ES5213, Permanent Speed Restriction Signs.
15. No trespassing signs shall conform to SCRRRA ES5214, No Trespassing and Tenth Mile Post Sign.
16. Stop, slow and resume speed flags and signs shall conform to SCRRRA ES5215, Stop, Slow and Resume Speed Flags and Signs.
17. Whistling Point/Quiet zone signs shall conform to SCRRRA ES5216, Whistling Point/Quiet Zone Sign.

18. Yard limit signs for terminal tracks shall conform to SCRRA 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 SCRRA ES5222, Station Signs for Other Than CTC Territory.
22. Mechanical Limit and No Ride Zone signs shall conform to SCRRA 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 SCRRA ES5229.
25. Bridge, trestle and culvert number signs shall conform to SCRRA ES6101, Bridge, Trestle and Culvert Numbers.
26. Radio channel sign shall conform to ES6103, Radio Channel Sign.
27. Tunnel exit sign shall conform to SCRRA ES6104, Tunnel Exit Sign.
28. Tunnel numbers shall conform to SCRRA ES6102, Tunnel Numbers.
29. Radio channel signs shall conform to SCRRA ES6103, Begin Channel Sign.
30. ATS sign shall conform to SCRRA ES8260, ATS Sign.
31. Emergency Notification Sign for Highway-Rail Crossing shall conform to SCRRA ES8270, Emergency Notification Sign for Highway-Rail Crossing.
32. Begin CTC/End CTC signs shall conform to SCRRA ES8291, Begin CTC/End CTC Sign.
33. Stop sign shall conform to SCRRA ES8292, Stop Sign.
34. Block signal with "P" Plate signs shall conform to SCRRA 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 railway 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 10 14 55**

## SECTION 12 67 23

### BENCHES AND TRASH CONTAINERS

#### 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 Metals

##### 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

- A. Delivery: Do not deliver benches or trash containers until the platform construction is ready for their installation.
- B. Store benches and trash containers in a manner to protect from harm, vandalism, or damage.

**PART 2 - PRODUCTS****2.01 MANUFACTURER**

- A. Trash Containers: Manufacturer indicated in plans or equal approved by the Engineer.
- B. Benches: Manufacturer indicated in plans or equal approved by the Engineer

**2.02 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.

**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 SCRRA, 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 12 67 23**



## 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).
- D. IEEE C2, National Electric Safety Code.
- E. UL 508A, Industrial Control Panels.
- F. ASTM A123, Standard Specification for Zinc (Hot-Dip galvanized) Coating on Iron and Steel products.
- G. ASTM A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

### 1.03 DEFINITIONS

- A. Product Types:
1. EMT: Electrical metal tubing, ANSI C80.3.
  2. FMC: Flexible metallic conduit.
  3. IMC: Intermediate metallic conduit, ANSI C80.
  4. LFMC: Liquid tight flexible metal conduit.
  5. RMC: Rigid metallic conduit, specifically rigid galvanized steel.
  6. RNC: Rigid nonmetallic conduit, NEMA PC-2.
  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 26 05 00**

## SECTION 26 05 43

### ELECTRICAL: EXTERIOR UNDERGROUND

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Specifier: Keep this description brief. The SUMMARY Article is intended to only outline the contents of topics in this Specification Section. Do not stipulate specification requirements in this Article.
- B. Section Includes:
  - 1. Material and installation requirements for:
    - a. Manholes.
    - b. Handhole.
    - c. Underground conduits and ductbanks.
- C. 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. A536, Standard Specification for Ductile Iron Castings.

3. National Fire Protection Association (NFPA):
  - 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.
  2. Minimum load ratings: SCTE 77 Tier 8.
  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.
3. Mating edges: Tongue and groove type.
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:
  1. Cast ductile iron: ASTM A536.
  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.
  6. Mounding hardware: Stainless steel.
- 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 manufacturers 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 13 00 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 26 05 43**

## 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

- A. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
- B. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
- C. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
- D. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
- E. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
- F. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.
- G. American National Standards Institute (ANSI).

- 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:
  1. Member company of the InterNational Electrical Testing Association.
    - 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:
  - 1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
  - 2. Low-Voltage Fuses: IEEE C37.46.
  - 3. Circuit Breakers: IEEE C37.13.
- 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: SCRRA 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 ARC FLASH 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/cm<sup>2</sup>.
- 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.
  - 4. Hazard risk category.
  - 5. Incident energy.
  - 6. Working distance.

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 26 05 50**



**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):
  - 1. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- 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.

- f. Article 620, Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts.
- 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:
    - a. Erico Products Inc., Cadweld.
    - 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:
    - a. Erico Products Inc., Cadweld.
    - 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:
1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
  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.
  4. Equipment Grounding Conductors: Insulated with green colored insulation.
  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:
    - a. Standards: UL 467.
    - b. High copper alloy content.
  - 2. Compression type for interior locations:
    - a. Standards: UL 467.
    - 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:
    - a. Standards: UL 467, IEEE 837.
    - 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.
  - d. Substations and Pad-Mounted Switching Equipment: 5 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 26 06 00**

## SECTION 26 07 10

### SEISMIC CONTROLS FOR ELECTRICAL WORK

#### 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):
  - 1. A36, Standard Specification for Carbon Structural Steel.
  - 2. A307, Standard Specification Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
  - 3. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- B. State of California Earthquake Regulations:
  - 1. Title 24, Section T22-94215. International Building Code (IBC) - 2006 Edition including all State of California amendments.

##### 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 ( $I_p$ ) is equal to 1.0.
  2. Electrical components in Seismic Design Categories D, E, and F where  $I_p = 1.0$  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  $I_p = 1.0$  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.
  2. Cooper B-Line Systems, div. Cooper Industries.
  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.
  9. Unistrut, div. Tyco Electrical and Metal Products.
- B. Restraints:
1. Indoor Dry Locations: Steel, zinc plated.

2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless 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.
  1. Materials for Channel: ASTM A1011.
  2. Materials for Fittings and Accessories: ASTM A575, ASTM A576, or ASTM A36.
  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 26 07 10**

## 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.
  - F. Interior Warning and Caution Signs: Comply with 29 CFR 1910.145.
  - G. Preprinted, aluminum, baked enamel finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
  - H. Exterior Warning and Caution Signs: Comply with 29 CFR 1910.145.
  - 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:
    - a. Fire Alarm System: Red.
    - b. Security System: Blue and yellow.
    - 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 26 07 50**

**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):
1. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
- B. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
1. 455-78-B, Optical Fibers - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

**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 26 08 00**



## 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):
  - 1. S-58-679, Standard for Control Cable Conductor Identification.
- 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.
  - 2. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- 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):
  - 1. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
  - 2. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
  - 3. 467, Standard for Safety Grounding and Bonding Equipment.
  - 4. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
  - 5. 486C, Standard for Safety Splicing Wire Connections.
  - 6. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
  - 7. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

8. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
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:
        - a) TSP: Twisted shielded pair.
        - b) 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.
    - h. American Insulated Wire Corp., a Leviton 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:
  - a. ICEA S-58-679, Method 4.
  - 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.
    - e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
    - 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  $\leq 3.4$  dB/Km.
    - e. Point discontinuity shall be  $\leq 0.2$  dB.
    - f. Effective modal bandwidth shall be  $\geq 220$  MHz-Km.
    - g. Cladding diameter shall be  $125.0 + \text{ or } - 2.0 \mu\text{m}$  with a core diameter of  $62.5 + \text{ or } - 3.0 \mu\text{m}$ , and the coating diameter of  $245 + \text{ or } - 5 \mu\text{m}$ .
- 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:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

\* Orange when it is a high leg of a 120/240 V Delta system.

- a. Conductors 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. Conductors 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:
  - a. Junction and pull boxes: Terminal block type connector.
  - 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 26 12 00**

## 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.
    - 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 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.
  - 5. O-Z/Gedney, div. EGS Electrical Group.
  - 6. Wheatland Tube Co., Div. Carlyle Group.
- B. Rigid Galvanized Steel Conduit: NEMA/ANSI C80.1.
- C. Aluminum Rigid Conduit: NEMA/ANSI C80.5.
- D. IMC: NEMA/ANSI C80.6.
- E. Plastic-Coated Galvanized Steel (PVC-coated RGS) Conduit and Fittings: NEMA RN 1.
- F. Plastic-Coated IMC and Fittings: NEMA RN 1.

- 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.
  - 4. CertainTeed Corp, Pipe & Plastics Group.
  - 5. Condux International.
  - 6. Elecsys Corporation.
  - 7. Electri-Flex Co.
  - 8. Carlon brand, Lamson & Sessions.
  - 9. RACO brand, Hubbell Inc.
  - 10. AFC Cable Systems, Div. Tyco Electrical and Metal Products.
  - 11. Thomas & Betts Corporation.
- 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.
  2. Hubbell, Inc., Wiring Device Division.
  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.
  6. O-Z/Gedney, div. EGS Electrical Group.
  7. RACO brand, Hubbell Inc.
  8. Robroy Industries.
  9. Adalet Enclosure Systems, div. Scott Fetzer Co.
  10. Spring City Electrical Manufacturing Co.
  11. Thomas & Betts Corporation.
  12. Wiremold / Legrand.
  13. Daniel Woodhead brand, Woodhead Industries, div. Molex Inc.

- 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.
  - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- 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 SCRRRA 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 SCRRRA Design Criteria and SCRRRA 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 26 13 00**

## **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 pre-marking 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:
    - a. Bryant Electric, div. Hubbell Inc.
    - b. Cooper Wiring Devices.
    - c. Hubbell Wiring Device-Kellems, div. Hubbell Incorporated.
    - 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:
1. Single and Double Pole Switches: Comply with DSCC W-S-896F and UL 20.
  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.
  3. Material for Unfinished Spaces: Galvanized steel.
  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, multi-gang 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 26 14 00**



## SECTION 26 28 00

### OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Low voltage circuit breakers.
  - 2. Motor Circuit Protector.
  - 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):
  - 1. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
  - 2. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
  - 3. C37.17, Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
- 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):
1. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
  2. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
  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  $I_p$  &  $I^2t$  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:
    - a. Eaton/Cutler-Hammer.
    - b. Schneider Electric/Square D.
    - c. Siemens.
    - d. General Electric.
  - 2. Fuses:
    - a. Bussman Manufacturing Division.
    - b. Eaton/Cutler-Hammer.
    - 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.
6. Typical: Current limiting.
7. UL Class:
  - a. Main, feeder and branch circuits, circuit breaker protection, and motor protection: RK1.
  - b. Motor, welder and transformer protection: RK5.
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 protectors 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 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 26 28 00**



## **SECTION 26 28 16**

### **SAFETY SWITCHES**

#### **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:
  - 1. Cutler-Hammer.
  - 2. General Electric Company.
  - 3. Square D Company.
  - 4. Siemens.
  - 5. Appleton Electric Company.
  - 6. Crouse-Hinds.
  - 7. Killark.
- 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):
    - a. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
    - 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 26 28 16**

## 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.
- E. IEEE Compliance: Comply with IEEE C62.41, IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits, and test devices according to IEEE C62.45, IEEE Guide for Surge Suppressor Testing.
- 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.



- 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 Deg F.
  - 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.
    - m. Transtector Systems, Inc., a Smiths Group company.
    - n. Zero Surge Inc.
  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.
- C. Peak Single-Impulse Surge Current Rating: 240kA per phase.
- 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/27; 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.
- B. Peak Single-Impulse Surge Current Rating: 80 kA per phase.
- 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 26 28 90**



## SECTION 26 41 00

### ENCLOSED SWITCHES AND CIRCUIT BREAKERS

#### PART 1 - GENERAL

##### 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.
  - 4. Siemens Energy & Automation, Inc.
  - 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.
    - a. Thermal Magnetic Circuit Breakers: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
    - 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 26 41 00**

## 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.
  - 8. Section 26 28 15 - Safety Switches.

##### 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.
  2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- 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 indicated, 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.
    - b. Cutler-Hammer brand, Eaton Electrical.
    - 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.
  - 2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
  - 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- 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.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- 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 26 42 00**

## **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.
  - 3. Short-circuit current rating of switchboards and overcurrent protective devices.
  - 4. Features, characteristics, ratings, and factory settings of individual Overcurrent protective devices and auxiliary components.
  - 5. Wiring Diagrams: Power, signal, and control wiring.
- 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.
  - 2. Cutler-Hammer brand, Eaton Electrical.
  - 3. General Electric Company.
  - 4. Siemens Energy & Automation, Inc.
  - 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.
14. Material for Main Bus: Hard drawn copper of 98 percent conductivity.
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.
19. Bus Transition and Incoming Pull Sections: Match and align with basic switchboard.
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: Integrally 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.
2. Thermal-Magnetic Circuit Breakers: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
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.
6. Long and short term pickup levels.
7. Long and short term time adjustments.
8. Ground fault pickup level, time delay, and I<sup>2</sup>t 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: Integrally 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:
  - a. Phase Currents, Each Phase:  $\pm 1$  percent.
  - b. Phase to Phase Voltages, Three Phase:  $\pm 1$  percent.
  - c. Phase to Neutral Voltages, Three Phase:  $\pm 1$  percent.
  - d. Megawatts:  $\pm 2$  percent.
  - e. Megavars:  $\pm 2$  percent.
  - f. Power Factor:  $\pm 2$  percent.
  - g. Frequency:  $\pm 0.5$  percent.
  - h. Megawatt Demand:  $\pm 2$  percent; demand interval programmable from 5 to 60 minutes.
  - i. Accumulated Energy, Megawatt Hours:  $\pm 2$  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.
  3. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
  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 26 44 10**

## 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.
    - c. Utility Underground Termination.
    - 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:
  1. Comply with UL 508A – Standard for Industrial Control Panels.
- 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.
  3. Comply with NFPA 70 – National Electrical Code.
  4. Comply with NFPA 79.

## **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.
  2. Cutler-Hammer brand, Eaton Corporation.
  3. General Electric Company.
  4. Siemens Energy & Automation, Inc.
  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.
  3. Skyline Electric & Co.
  4. Meyers Power Products.
- 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.
  4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
  5. Bus: Hard drawn copper, 98 percent conductivity.
  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.
  9. Spaces for Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
  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.
    - a. Thermal Magnetic Circuit Breakers: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
    - 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 26 44 20**

## SECTION 26 46 00

### DRY TYPE TRANSFORMERS (600V 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:
  1. Acme Electric Corporation, Power Distribution Products Division; subsidiary of Actuant Corporation.
  2. Cutler-Hammer brand, Eaton Electrical.
  3. GE, Electrical Distribution division.
  4. Magnetek, Inc.
  5. Siemens Energy & Automation, Inc.
  6. Sola/Hevi-Duty, member EGS Electrical Group.
  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.
  - 3. Finish Color: ANSI 61 gray.
- 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,  $\pm 5$  percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

**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 26 46 00**

## 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):
  - 1. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.
- D. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- 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).
  2. 101, Life Safety Code.
- H. Underwriters Laboratories, Inc. (UL):
1. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
  2. 508, Standard for Safety Industrial Control Equipment.
  3. 924, Standard for Emergency Lighting and Power Equipment.
  4. 935, Standard for Fluorescent-Lamp Ballasts.
  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 REQUIREMENTS**

- 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.
  3. Ballasts: Fixture manufacturer's standard.
  4. Emergency ballasts: Bodine.
  5. Emergency transfer devices: Bodine.
  6. Poles: Fixture manufacturer's standard.
- 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.



14. Meet IEEE C62.41 Cat. A for transient protection.
  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.
  4. Double-pole test switch.
  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.
  3. Secure HID fixtures with safety chain.
- 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.
    - b. Standard: UL 248-4.
  - 2. Fuseholder:
    - a. Watertight, in-line and break-a-way style.
    - 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 26 50 00**

## SECTION 28 13 00

### ACCESS CONTROL SYSTEM (ACS)

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. This section describes the minimum requirements for the SCRRA 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 SCRRA is Identocard PremiSys Pro by Identocard 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 SCRRA 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

<b>Abbreviation</b>	<b>Description</b>
#A	Ampere
ACO	Alarm Company Operator
ACS	Access Control System
CSLB	Contractors State License Board (California)
DIP	Dual In-Line Package
EOL	End of Line
FIPS	Federal Information Processing Standards
HID	HID Corporation
Hz	Hertz
ID	Identification
I/O	Input/Output
IP	Internet Protocol
IT	Information Technology
LAN	Local Area Network
LED	Light-Emitting Diode
MB	Megabyte
MUX	Multiplexer
OSDP	Open Supervised Device Protocol

PC	Personal Computer
SCRRA	Southern California Regional Rail Authority
SDRAM	Synchronous Dynamic Random-Access Memory
SRAM	Static Random-Access Memory
UL	Underwriters Laboratories, Inc.
V	Volts
VAC	Volts Alternating Current
VDC	Volts Direct Current
YMCKO	Yellow, Magenta, Cyan, Black, Clear Overlay

#### 1.04 GENERAL REQUIREMENTS

- A. All work and materials shall conform to all applicable SCRRA, 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 SCRRA 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 SCRRA.
- 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 SCRRA.
- 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 Identocard 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 Identocard PremiSys Pro software by Identocard Systems.
- C. Any existing legacy hardware (e.g. Identocard Series 9000 Panels) shall be replaced with hardware listed in this section, and designed for use with the Identocard 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 Identocard PremiSys Pro by Identocard Systems. No exceptions.
- B. Contractor to provide Identocard 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. Identocard PremiSys Two-Reader Controller, model PREM-CTLR2RDR, 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. Identocard 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. Identocard 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. Identocard 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  $\pm$  15% at 250 mA for power.

8. Identocard 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.
6. Card Reader: HID multiCLASS SE models RP10, RP15, RP30, RP40 (no substitutions)
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
  - 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 SCRRA 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 SCRRA, 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 SCRRA 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, SCRRA 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 SCRRA.
- 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 Identocard 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 SCRRA. Complete checklists as work is completed, and provide them to the construction manager or SCRRA.
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 SCRRA. 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 28 13 00**

## 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

<b>Abbreviation</b>	<b>Description</b>
CAT-6	Category 6
CIS	Customer Information System
EIA	Energy Information Administration
EIS	Electronic Image Stabilization
FOPP	Fiber Optic Patch Panel
FOV	Field of View
GB	Gigabyte
Gbps	Gigabits per Second
GHz	Gigahertz
HD	High Definition
HDD	Hard Disk Drive
HDTV	High Definition Television
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
JPEG	Joint Photographic Experts Group
KVM	Keyboard-Video-Mouse
LAN	Local Area Network
LCD	Liquid Crystal Display
Mbps	Megabits per Second
MIMO	Multiple-Input and Multiple-Output
MMFO	Multimode Fiber Optic
MP	Megapixel

MPEG	Moving Picture Experts Group
NAS	Network-Attached Storage
NEMA	National Electrical Manufacturers Association
NVR	Network Video Recorder
ONVIF	Open Network Video Interface Forum
OS	Operating System
PC	Personal Computer
PoE	Power-over-Ethernet
PSE	Power Sourcing Equipment
PTZ	Pan-Tilt-Zoom
RAID	Redundant Array of Independent Disks
RJ45	Registered Jack 45
SCRRA	Southern California Regional Rail Authority
SFP	Small form-factor pluggable
SSD	Solid State Driver
TB	Terabyte
TCP/IP	Transmission Control Protocol/Internet Protocol
UL	Underwriters Laboratories
UPS	Uninterruptable Power Supply
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair
VAC	Volts Alternating Current
VDC	Volts Direct Current
VGA	Video Graphics Array
VLAN	Virtual Local Area Network
VMS	Video Management Software
VOIP	Voice over Internet Protocol
VSS	Video Surveillance System

#### 1.04 SUBMITTALS

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 SCRRA personnel in accordance with established SCRRA 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 SCRRA 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 SCRRA 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

- h. Pendent mount
  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  $\pm 180^\circ$ , tilt -5 to  $+75^\circ$ , rotation  $\pm 95^\circ$
  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: galvanized 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 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 SCRRA.
- 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 SCRRA 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 SCRRA 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, SCRRA 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. SCRRA 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 SCRRA 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 SCRRA approval.

### 3.02 TESTING

- A. Factory and field testing shall be performed in accordance with SCRRA 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 SCRRA.
- D. Perform the following local field operations tests on site in accordance with an SCRRA 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 28 23 00**

## SECTION 29 00 00

### SUMMARY OF CUSTOMER INFORMATION SYSTEM (CIS) WORK

#### 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 SCRRA 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, SCRRA 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.
- E. 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.

#### **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 29 00 00**

## SECTION 29 00 20

### STANDARDS, ABBREVIATIONS, AND DEFINITIONS FOR CUSTOMER INFORMATION SYSTEM (CIS)

#### 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

Agency	Standard Description
ASTM	ASTM A53 Standard Specifications for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
CIS	Customer information system
DOT	Americans with Disabilities Act (ADA) Requirements
EIA	EIA-232 Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
EIA	EIA-310 Racks, Panels, and Associated Equipment
EIA	EIA-485 Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
EIA	EIA/TIA-530-A High Speed 25-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment, Including Alternative 26-Position Connector
EIA/TIA	EIA/TIA-568 Commercial Buildings Telecommunications Wiring Standard
EIA/TIA	EIA/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
EIA/TIA	EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
EIA/TIA	EIA/TIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
FCC	FCC Class A Part 15 Emissions Requirements
IEEE	IEEE 42 Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)

<b>Agency</b>	<b>Standard Description</b>
IEEE	IEEE 1100 Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)
NEMA	NEMA AB1 Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA	NEMA ICS6 Industrial Controls and Systems Enclosures
NEMA	NEMA TC2 Electrical Polyvinyl Chloride (PVC) Conduit
NEMA	NEMA TC3 PVC Fittings for use with Rigid PVC Conduit and Tubing
NEMA	NEMA VE1 Metallic Cable Tray Systems
NEMA	NEMA WC-70 Non Shielded Power Cable 2000V or less
NEMA	NEMA WD1 General Requirements for Wiring Devices
NFPA	NFPA-70 National Electrical Code
NFPA	NFPA 75-Standard for the Protection of Electronic Computer/Data Processing Equipment
NFPA	NFPA-258 Test for Determining Smoke Generation of Solid Materials
NTCIP	NTCIP-1203 Object Definitions for Dynamic Message Signs
NTCIP	NTCIP-2201 Transportation Transport Profile
UL	UL 6 Electrical Rigid Metal Conduit – Steel
UL	UL 13 Power Limited Circuit Cables
UL	UL 48 Electric Signs
UL	UL 96 Lighting Protection Components
UL	UL 360 Liquid Tight Flexible Steel Conduits
UL	UL 444 Communications Cables
UL	UL 467 Grounding and Bonding Equipment
UL	UL 497 Protectors for Paired Conductor Communications Circuits
UL	UL 497A Secondary Protectors for Communications Circuits
UL	UL 514 Fittings for Conduit and Outlet Boxes
UL	UL 1433 Standard for Control Centers for Changing Message Type Electric Signs
UL	UL 1449 Transient Voltage Surge Suppressors
UL	UL 1581 Electrical Wires, Cables, and Flexible Cords

**1.03 ABBREVIATIONS**

<b>Abbreviation</b>	<b>Description</b>
A	Amperes
AC	Alternating Current
ADA	Americans with Disabilities Act
A-D/D-A	Analog to Digital/Digital to Analog
ANS	Ambient Noise Sensor
BNC	Bayonet Neill-Concelman
BTU	British Thermal Units
C&S	Communications and Signaling
CMS	Changeable Message Sign
CIS	Customer Information System
CVBS	Composite Video Baseband Signal
EMP	Emergency Management Panel
FO	Fiber Optic
FOPP	Fiber Optic Patch Panel
GRS	Galvanized Rigid Steel
Hz	Hertz
HDMI	High Definition Multimedia Interface
IC	Interface Converter
I/O	Input/Output
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MC	Media Converter
MCI Building	SCRRRA Headquarters in Downtown Los Angeles
MOC	Metrolink Operations Center
MPLS	Multi Protocol Label Switching
NMP	Network Media Player
NTCIP	National Transportation Communications for ITS Protocol
PA	Public Address
PC	Personal Computer
PIP	Picture-in-Picture
SCRRRA	Southern California Regional Rail Authority
SFP	Small Form Factor Pluggable

<b>Abbreviation</b>	<b>Description</b>
SOW	Statement Of Work
TCIP	Transit Communications Interface Profile
TFT	Thin Film Transistor
THD	Total Harmonic Distortion
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply
USB	Universal Serial Bus
V	Volts
VGA	Video Graphics Array
VLAN	Virtual Local Area Network

**PART 2 - PRODUCTS (NOT USE)**

Not applicable to this Section.

**PART 3 - EXECUTION (NOT USE)**

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 29 00 20**

## SECTION 29 10 60

### POWER DISTRIBUTION TESTING AND COMMISSIONING

#### 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. Network Media Player (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 SCRRA's review and Approval. SCRRA 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 SCRRA. If Disapproved the Contractor shall correct the deficiencies and resubmit the procedure to SCRRA for Approval at no additional cost to SCRRA. 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 SCRRA for site access and access to SCRRA's locked communications shelters and cabinets.
  4. Step-by-step description of the equipment setup, and step-by-step instructions for conducting testing.
  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 SCRRA 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 SCRRA for review and Approval.
- D. The Contractor shall obtain Approval for testing, test and verify insulation resistance. The test results shall be submitted to SCRRA for review and Approval.
- E. The Contractor shall give at least two weeks notice to SCRRA prior to the testing date. SCRRA 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 SCRRA for review and Approval.

- F. If any of the above tests fail and results are Disapproved by SCRRA, the Contractor, at no additional expense to SCRRA 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 29 10 60**

## SECTION 29 20 20

### COMMUNICATIONS SERVICES

#### PART 1 - GENERAL

##### 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, enclosures, and sign sunshields.
  9. Fiber optic patch panels, cables, and connectors.
  10. Audio cables and connectors.
  11. Power 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 DOC/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
  4. Section 29 00 00 – Summary of Work CIS Work.
  5. Section 29 00 20 - Standards, Abbreviations, and Definitions for CIS
  6. 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 1 - Material List**

<b>Item No.</b>	<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
1.	Ethernet Switch	Cisco	SRW2048
2.	Audio Amplifier	Crown	CTs 4200
3.	Priority Controller	BSS Audio	BLU-16
4.	42" Commercial LCD Display	Viewsonic	CD4220
5.	Network Media Player	Viewsonic	NMP-530, VS11681
6.	Strobe Light	Federal Signal	131DST
7.	Audio Decoder	MDOUK	Audio TX STL-IP-1
8.	Environmental Distribution Center	Corning	EDC-02P-NH
9.	LED Message Display	Daktronics Signs	AF-6300, See Section 3.02
10.	EMP	AT&T	PI 305
11.	Rack Mount Connector Housing	Corning	PCH-04U
12.	Transient Voltage Suppression	Eaton Innovative Technology	PT Series
13.	UPS	Eaton Innovative Technology	9130
14.	Closet Connector Housing – Pigtail Modules	Corning	CCH-CP-12-G7
15.	Splice Trays	Corning	M67-048
16.	Bracket Inside Connector Housing	Corning	PC4-SPLC-12SR
16.	LCD Enclosure (Including 42" monitor enclosure, insulation, enclosure post, brackets, mounts, T20 2000 BTU Air Conditioner/Heater), Stainless Steel mounting post and brackets	ITS Enclosures	Various, See Section 3.05
17.	Speakers	University Sound	PA430T
18.	Modular Media Converter	Opterna	12000C
19.	Speaker Cable	Belden	1311 A
20.	Ambient Noise Sensor/2 Wire Handset/Microphone Cable	Belden	1776
21.	Audio Cable	Belden	6300FE
22.	HDMI Cable	Belden	HD2003

- 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 (minimum OM2), 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  $\leq 3.4$  dB/Km.
  - 2) Point discontinuity shall be  $\leq 0.2$  dB.
  - 3) Effective modal bandwidth shall be  $\geq 220$  MHz-Km.
  - 4) Cladding diameter shall be  $125.0 + \text{ or } - 2.0$   $\mu\text{m}$  with a core diameter of  $62.5 + \text{ or } - 3.0$   $\mu\text{m}$ , and the coating diameter of  $245 + \text{ or } - 5$   $\mu\text{m}$ .
- 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 DOC, MOC, and Gateway Building, and the EMP conducted by the Contractor with AUTHORITY and SCRRA's 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, DOC, MOC, Gateway building, or via pre-recorded messages stored, activated, and transmitted from the DOC/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.

Priority Level	Input
First	From the EMP
Second	From Microphone in AUTHORITY Security Room
Third	From DOC, MOC, and Gateway
Fourth	Pre-recorded announcements

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 DOC/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 SCRRA'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 SCRRRA. 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 (minimum OM2) 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 be 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 (3<sup>rd</sup> 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. Use cable management equipment such as cable ties where possible.
- 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.
- H. Adequate cable slack shall be provided to prevent taut cables.

#### **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 Converter 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 29 20 20**

## 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 USED)

Not Applicable to this Section.

#### PART 3 - EXECUTION

- A. SCRRA may choose to witness any or all the tests. The Contractor shall furnish a written notice at least two (2) weeks in advance to SCRRA before the testing is scheduled to begin. SCRRA 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 SCRRA'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 SCRRA.
  - 4. Step-by-step description of the equipment setup, and step-by-step instructions for conducting testing.
  - 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.
- F. 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.

**END OF SECTION 29 20 60**

## **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. Section 01 33 00 – Submittal Procedures
  - 2. Section 01 74 19 – Construction Waste Management and Disposal
  - 3. Section 31 11 50 – Demolition, Cutting, and Patching
  - 4. Section 32 91 00 – Soil Erosion, Sediment Control, Topsoiling and Seeding

##### **1.02 REFERENCES**

- A. Standard Specifications for Public Works Construction, SSPWC: Current Version

##### **1.03 SUBMITTALS**

- A. General:
  - 1. Submittals shall be made in accordance with Section 01 33 00 requirements.
  
- B. Site Clearing Plan:
  - 1. A site clearing plan shall 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 SCRRA:
    - 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.
      - 1) Releases shall absolve SCRRA and its member agencies from any responsibility in connection with the disposal of materials on private property.
      - 2) Releases shall be signed by the owner(s) of the property on which the material will be deposited.
      - 3) 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.

#### **1.04 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 USED)**

## **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.
  - 2. Remove trees that are damaged to the extent that a certified arborist or tree surgeon determines they cannot be repaired and restored to full-growth status.
    - a. Replace with new trees of minimum 4 inches trunk diameter measured by caliper.
  - 3. Damaged vegetation shall be replaced in-kind as approved by the Engineer.
  - 4. Existing site improvements will be repaired or replaced as approved by the Engineer.
  - 5. Irrigation systems shall be modified to accommodate the work 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 to a designated area directed by the Engineer.
    - a. Construct stockpiles to freely drain surface water.
    - b. Provide temporary cover or seeding of stockpiles to prevent erosion in accordance with Section 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 diameter, weeds and roots.
  5. Clearing: Clear from within limits of construction all trees except those marked to remain. Maintain worksite in this cleared condition.
    - 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 and reference Section 300-1.3 "Removal and Disposal of Materials" of the Standard Specifications for Public Works Construction, Current Edition. 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 diameter 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**

### **4.01 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.

**4.02 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 31 11 00**

## 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. Section 31 11 00 – Site Clearing
  - 2. Section 31 20 00 - Earthwork
  - 3. Section 31 50 00 - Excavation Support
  - 4. Section 32 91 00 - Soil Erosion, Sediment Control, Topsoiling and Seeding
  - 5. Section 34 72 00 – Trackwork
  - 6. Section 34 72 30 – Field Welding Rail

##### 1.02 SUBMITTALS

- A. General
  - 1. Submittals shall be made in accordance with Section 01 33 00 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 Authority's 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 SCRRA, 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 the Authority's 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 the Authority as identified in the Plans.
- C. The Contractor shall replace or repair, at no expense to the Authority, 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 Section 32 91 00.
- D. The Contractor shall replace at no expense to the Authority 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. Signal/Utility poles shall be saw cut a minimum of 2 feet below the ground line. 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 Section 31 20 00.

### **3.07 CULVERT AND HEADWALLS**

- A. Stormdrain culverts under track and concrete headwalls shall be demolished as indicated on the plans and removed in accordance with the submitted and approved site demolition plan. The Contractor shall replace at no expense to the Authority any existing pipe designated to remain in place damaged by the Contractor.

### **3.08 TRACKWORK AND TURNOUTS**

- A. Remove trackwork for track reconstruction as described in Section 34 72 00 Trackwork and this Specification
- B. Cut track to limits shown on the Plans or as called for in this Specification. Rail shall be cut with rail saw to a tolerance of 1/32 inch from square. All burrs shall be removed and ends made smooth. Torch cut rails will be rejected.
- C. Remove trackwork, including rail, ties, ballast, subballast, and other track materials in accordance with this Section.
- D. Removal and salvage of turnouts or crossovers includes removal of all special trackwork components and delivery to the Authority as directed by the Engineer or per the Plans.
- E. Remove insulated joints as described in Section 34 72 30 Field Welding Rail and this Specification.
- F. Removal of insulated joints to be coordinated with the Signal Contractor and SCRRRA.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

- A. Existing facilities to be reconstructed, re-laid, 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 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. 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 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.
- I. Removing, salvaging, reconstruction, relocating, or resetting the various types of track demolition, turnouts, crossover and special trackwork 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 Documents 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, incidentals, and for doing all the Work involved in completing the operations as shown or depicted on the Plans, and as specified in these Specifications, or as directed by the Engineer.
- C. Full compensation for all excavation and backfill required to remove, dispose of, salvage, relay, reset, relocate, and/or 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.
- 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 SCRRRA's right-of-way. No payment will be considered without such certificates.

**END OF SECTION 31 11 50**

## **SECTION 31 20 00**

### **EARTHWORK**

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

##### **1.01 SUMMARY**

- A. Section Includes:
1. Excavation, embankment fill, structural excavation and backfill, borrow, sub-grade preparation, 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 consist of furnishing, installing, and compacting backfill material around structures.
- B. Related Specification Sections include but are not necessarily limited to:
1. Section 03 31 00 – Structural Concrete
  2. Section 31 11 00 - Site Clearing.
  3. Section 31 11 50 - Demolition, Cutting And Patching.
  4. Section 31 50 00 - Excavation Support.
  5. Section 34 11 27 - Sub-Ballast and Aggregate Base.
  6. Section 34 71 50 – Highway-Rail Grade Crossings

##### **1.02 REFERENCES**

- A. ASTM International (ASTM):
1. C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  2. D1556, Standard Test Method for Density and Unit Weight of Soil In Place by the Sand Cone Method.
  3. D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m)).
  4. D2419, Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

5. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
  6. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  7. D4829, Standard test Methods for Expansion Index of Soils.
  8. 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.
- C. Standard Specifications for Public Works Construction, Current or Latest Edition, Section 300 – Earthwork.
- D. Caltrans Section 19 - Earthwork

### 1.03 SUBMITTALS

- A. General:
1. Submittals must be made in accordance with Section 01 33 00 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 the work of this section. (on-SCRRRA property and off SCRRRA property).
  2. Plans shall include, as necessary, haul routes, public streets to be used, traffic control and other incidental work necessary to complete the work of this section (on-SCRRRA property and off SCRRRA property).
  3. Contractor must submit a 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.
    - c. Extent and depth of subgrade preparation based on project specific geotechnical report or existing site conditions.
  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.
    - c. Proposed temporary erosion and sediment control measures should be included.
    - d. Extent and depth of subgrade preparation based on project specific geotechnical report or existing site conditions.
  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.
    - d. Proposed temporary erosion and sedimentation control measures should be included.
    - e. Extent and depth of subgrade preparation based on project specific geotechnical report or existing site conditions.
- 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 Contractor 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 shall 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 shall not be used in the Work.

#### **1.05 SITE CONDITIONS**

- A. Contractor shall execute Work under this Specification in such a manner as to minimize impact to the daily operation of SCRRA, vehicular, bicycle, 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 SCRRA 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.
- E. The Contractor shall maintain in good working order all erosion and sedimentation controls throughout the duration of the work.

### **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. Fill and Backfill:

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 shall 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 1, Structural Backfill**

Sieve Sizes	Percentage Passing
3"	100
No. 4	35-100
No. 30	20-100

3. Material shall be free of stones or lumps exceeding 3 inches 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 the top 2 feet of finished grade at abutments, abutment wing walls, retaining walls, and other portions of structures shall be compacted impervious material.
  - a. 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 Contractor shall either:
  - 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 that meets the requirements for structural backfill. No additional compensation will be allowed.
  - c. Treat the unsuitable material to meet the requirements for structural backfill. No additional compensation will be allowed.
  - d. Use Controlled Density Fill (CDF). No additional compensation will be allowed.
  - e. Obtain material elsewhere from Contractor sources. No additional compensation will be allowed.

The Contractor shall submit in writing to the Engineer for approval of the substitution that is being requested.

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 shall 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 03 31 00.

D. Pervious Backfill Material:

1. 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

E. 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"	90 - 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.
- F. 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, subgrade preparation, 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 SCRRA Standard Specification 31 11 00.
    - b. Perform other construction staking work required.
  - 3. The Contractor must not place any embankment fill or sub-ballast onto 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. Subgrade 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 than 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 Design Criteria Manual, Chapter 15, Excavation Support Criteria, constructed in accordance with Section 31 50 00, and these Specifications is installed.
6. Subgrade 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 SCRRA 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 from insufficient or improper compaction of such material shall be corrected by the Contractor throughout the Contract period at no additional cost to the Authority. 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 SCRRA 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.
    - 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. SCRRA 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 SCRRA.

### **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 SCRRA 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. Excavation and backfill will be acceptably excavated or filled within the limits of lines and slope described in typical sections and cross sections in the plans and contract documents. 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 31 20 00**

## SECTION 31 20 50

### REMOVAL AND DISPOSAL OF CONTAMINATED SOILS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

General: Soil on Project Worksite shall be managed per Contractor's approved Soil Management Plan within confines of Project Worksite including chemically-impacted soil that is encountered which exceeds thresholds for hazardous waste per these specifications.

1. Soil for export must undergo sampling and chemical analyses.

Section Includes:

1. Methods and procedures to be used for stockpiling, characterization, disposal of excess soil (export soil)
2. Methods and procedures to be used for handling and disposal of unanticipated chemically-impacted soil (including hazardous waste) encountered during excavation activities anywhere on Worksite.

Related Sections include but are not necessarily limited to:

1. Section 01 14 00 – Work Restrictions
2. Section 01 35 44 – Environmental Safety and Health Program
3. Section 01 57 19 – Temporary Environmental Controls
4. Section 31 11 00 – Site Clearing
5. Section 31 20 00 – Earthwork
6. Section 32 91 00 – Soil Erosion, Sediment Control, Top Soiling and Seeding

##### 1.02 DEFINITIONS

###### SOIL CATEGORIES

Category 1: Non-Impacted Soil – Soil exhibiting no signs of visible staining, odor, discoloration, free product or with a portable photoionization detector (PID) reading less than 50 parts per million by volume (ppm<sub>v</sub>) when calibrated to hexane and held no more than 3 inches from the soil surface.

Category 2: Potentially Chemically-Impacted Soil – In-place soil exhibiting visible staining, odor, discoloration, free product or with a portable photoionization detector

(PID) reading equal to or exceeding 50 ppm<sub>v</sub> when calibrated to hexane and held no more than 3 inches from the soil surface. **This is a temporary soil category.** Potentially-contaminated soil is sampled and subjected to laboratory analysis after which it will be categorized as non-impacted soil, chemically-impacted soil or hazardous waste soil depending upon the laboratory analytical results and the established regulatory concentration limits that distinguish between the categories.

Category 3: Chemically-Impacted Soil – Excavated soil that is sampled and analyzed by a laboratory where the results show concentrations of chemicals of concern (COCs) exceeding the United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs), with the exception of arsenic, for which the RSL shall be modified from 1.6 mg/kg to 12 mg/kg, but below concentrations that meet or exceed the criteria of hazardous waste soil as defined in 22 CCR section 66261.3

Category 4: Hazardous Waste Soil – Excavated soil that is sampled and analyzed by a laboratory where the results show concentrations of COCs meeting the criteria of hazardous waste as defined in 22 CCR section 66261.3. The hazardous waste soil is classified as either being subject to RCRA, found in 40 CFR, or it is subject to HSC and 22 CCR. The hazardous waste categories include acutely hazardous waste, extremely hazardous waste, non-RCRA hazardous waste, RCRA hazardous waste, special waste and universal waste (further described in Article 3.05 D).

#### DEFINITIONS (OTHER)

Characterization of Soil – Soil identified as as potentially chemically-impacted soil (temporary soil category) shall be sampled and analyzed by a NELAP-certified environmental laboratory to determine which of the three final soil categories (non-impacted, chemically-impacted or hazardous waste soil) the soil belongs to in order to determine the proper handling, stockpiling, storage, and off-site disposal requirements described in this section.

Volatile organic compounds, or VOCs - organic chemical compounds whose composition makes it possible for them to evaporate under normal atmospheric conditions of temperature and pressure. Since the volatility of a compound is generally higher the lower its boiling point temperature, the volatility of organic compounds are sometimes defined and classified by their boiling points.

### 1.03 PERFORMANCE REQUIREMENTS – PROCESS RELATIVE TO DISCOVERY OF POTENTIALLY CHEMICALLY- IMPACTED SOIL

Due to the potential for encountering chemically-impacted soil anywhere on Worksite, Contractor's excavation work shall be modified as follows:

1. Comply with requirements outlined in this Section.
2. Use reference documents and data provided by the Authority to anticipate the location and extent of chemically-impacted soil within the work area.
3. When required, characterize soil in-place to determine which of the four categories the soil belongs to.

4. Notify the Authority upon discovery of chemically-impacted soil or hazardous waste soil.
5. Contractor shall perform sample collection from potentially chemically- impacted soil in-place or in stockpiles for transport and disposal, as required. Refer to Article 3.05.
6. If so directed, based on observation(s) and initial analysis(es), segregate and stockpile soil based on category: 1. non-impacted soil; 2. potentially chemically-impacted soil (until final soil category is determined); 3. chemically-impacted soil; and 4. hazardous waste soil. Separating stockpiles based on soil categories prevents cross-contamination and prevents stormwater discharge from soil categories 2, 3 and 4 stockpiles, in accordance with the Project Storm Water Pollution Prevention Plan (SWPPP).
7. If soils are documented as a result of sampling and analyses as category 3 – chemically-impacted soil, then Contractor shall propose appropriate procedures for loading, transport, and disposal of chemically-impacted soil at an appropriately permitted disposal facility. Contractor to submit proposed procedures per Article 1.04 below, for review and approval by the Authority.
8. If soils are documented as result of sampling and analyses as category 4 – hazardous waste soil, as set forth by regulatory agencies, then Contractor shall propose appropriate procedures for loading, transport, and disposal of hazardous waste soil at an appropriately permitted disposal facility. Contractor to submit proposed procedures per Article 1.04 below, for review and approval by the Authority.

#### **1.04 SUBMITTALS**

Submit under Section 01 33 00 Submittal Procedures.

Before starting soil grading, excavating, and handling, Contractor shall submit:

1. Contractor's qualifications for handling and disposing of chemically-impacted soil as well as qualifications for handling and disposing of soil defined as hazardous waste.
2. Soil Management Plan, which shall include:

Worksite plan showing proposed locations on Project Worksite of temporary storage stockpiles. Indicate distances to existing storm drain catch basins. Show location of storage tanks for leachate and stormwater pumping.

Details of stockpile design, including liner material and thickness, foundation material with method of protecting liner against equipment damage, berm materials and height, spacing of toe of stockpile to berm, cover material and thickness, and sandbag layout.

Soil category stockpile segregation and separation approach shall be part of the stockpile design. The stockpile design shall recognize and provide for the four soil categories: 1. non-impacted soil; 2. potentially chemically-impacted soil; 3. chemically-impacted soil; and 4. hazardous waste soil.

Means and methods for characterization sampling, laboratory analysis, and waste profiling.

Details for handling material that is potentially-contaminated or has previously been categorized as chemically-impacted soil or hazardous waste soil.

Method for equipment decontamination after completion of chemically-impacted soil and hazardous waste soil work. Material temporarily categorized as potentially chemically-impacted that has been in contact with equipment should be treated as chemically-impacted unless and until laboratory results indicated it is non-contaminated material. Include decontamination structural best management practices (BMPs) such as rumble plates, tire brooming, and bermed washdown area.

Sampling procedure and characterization plan for leachate liquids and name of independent analytical laboratory.

BMPs for containing chemically-impacted soil, hazardous waste soil and wash water within staging area, as discussed in Section 32 91 00 Soil Erosion, Sediment Control, Top Soiling and Seeding.

BMPs for containing runoff from Project grading areas, as discussed in Section 32 91 00 Soil Erosion, Sediment Control, Top Soiling and Seeding.

3. Submit Credentials of supervising personnel holding State of California registered professional geologist or professional engineer license.

Before starting soil grading, excavating, and handling, provide for the Authority's file copy of Contractor's site-specific Health and Safety Plan (HASP), complying with 29 CFR 1910.120.

40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training certificates (Code of Federal Regulations [CFR] Standard 29 Part 1910.120) and current 8-hour refresher training certificates for workers planned to be involved in excavation and handling of potentially chemically-impacted soil, chemically-

impacted soil and/or hazardous waste soil. HAZWOPER trained workers may also be required if chemically-impacted soil or hazardous waste soil is to be considered an exposure hazard to workers, in accordance with Contractor's site-specific HASP.

Before starting soil grading, excavating, and handling, submit for the Authority's approval Contractor's plan for sequencing of excavation, hauling routes, and soil stockpile management.

During excavation, handling and stockpiling work, submit:

1. Daily documentation of soil quantities excavated, classification of soil, the procedures used for the handling of different soil categories during the work, and quantities of each soil category exported.

After sample analysis, export of non-impacted soil shall comply with specifications set out in Section 31 20 00 Earthwork.

The Authority, as the Generator of Waste, shall provide the following to the contractor:

1. EPA identification (ID) Number for this project, if applicable.
2. Generator name.
3. Generator address.
4. Site address.
5. Contact name and phone number of the Authority representative who will be signing the bills of lading (for soil categories of non-impacted and chemically-impacted) and manifests (for the hazardous waste soil category).

Submit for the Authority approval letters of commitment from waste transporters agreeing to handle soil that shall be disposed of off-site as chemically-impacted soil or hazardous waste soil. Commitment letters shall include:

1. EPA ID number.
2. California Department of Transportation (DOT) license.
3. Equipment and methods for loading and hauling.

Submit for the Authority's files, copies of waste profile documentation that Contractor submitted to proposed disposal facilities for chemically-impacted soil.

Submit for the Authority's files, copies of hazardous waste profile documentation that Contractor submitted to proposed hazardous waste soil disposal facilities.

Before soil loading for disposal as chemically-impacted soil, submit to the Authority for review and signature completed copies of bills of lading for each load of chemically-impacted soil that has been properly characterized as chemically-impacted soil based on laboratory analysis results.

Before soil loading for disposal as hazardous waste soil, submit to the Authority for review and signature completed copies of waste manifests for each load of hazardous waste soil that has been properly characterized as hazardous waste soil based on laboratory analysis results.

Within two business days after notification of receipt at disposal facility, submit for the Authority's files completed bill of lading and waste manifest records.

Submit for the Authority's files Contractor's log for tracking disposal information for chemically-impacted soil and hazardous waste soil removed from Worksite. Disposal log shall include:

1. Name and location of disposal facility.
2. Bills of lading/Waste manifests numbers.
3. Date transported from Worksite.
4. Date received at disposal facility.
5. Hazardous waste type (for hazardous waste soil).
6. Estimated load weight at departure from Worksite.
7. Load weight as measured at disposal facility.

Submit for the Authority's files, copies of weight records obtained from disposal facilities.

### **1.05 REGULATORY REQUIREMENTS**

Contractor Licensing – Excavation and handling of hazardous waste soil shall be performed by Contractor appropriately licensed in the State of California and with Hazardous Substance Removal Certification (CCR, Division 9, Title 16, Article 3. Classification). This same Contractor shall have a valid South Coast Air Quality Management District (SCAQMD) Rule 1166 Various Locations Permit to be used at Project Worksite. If the material being excavated and handled has not yet been categorized, for the purposes of contractor licensing the hazardous waste soil requirements shall apply.

Training – Personnel working with hazardous waste soil shall be 40-hour trained under HAZPOWER requirements (29 CFR 1910.120) and have current 8-hour HAZPOWER refresher within the past year. If the material being excavated and handled has not yet been categorized, for the purposes of contractor training the hazardous waste soil requirements shall apply.

Contractor shall comply with HAZWOPER requirements including:

1. Training.
2. Training refreshers.

3. Medical surveillance.
4. Safety and health program implementation.

Contractor shall also prepare site-specific HASP complying with HAZWOPER requirements for excavation and other work related to excavating, handling or otherwise coming in contact with potentially chemically-impacted soil, chemically-impacted soil and hazardous waste soil.

Contractor licensing and training for personnel working with soil identified as chemically-impacted soil or hazardous waste soil shall be determined by Contractor's site-specific HASP.

Personnel lacking HAZWOPER training shall not excavate, handle or otherwise come into contact with potentially chemically-impacted soil, chemically-impacted soil, or hazardous waste soil. Contractor shall designate, mark, and enforce an exclusion zone in accordance with Contractor's site-specific HASP to prevent unauthorized contact with potentially chemically-impacted soil, chemically-impacted soil and hazardous waste soil. Contractor shall also supply, construct, and maintain a decontamination area for personnel and equipment at the perimeter of the exclusion zone.

Emissions Control – Contractor must comply with requirements of SCAQMD, including:

1. Rule 401, Visible Emissions.
2. Rule 402, Nuisance.
3. Rule 403, Fugitive Dust.
4. Rule 1166, Volatile Organic Compound Emissions.

Stormwater Pollution Prevention – Contractor must comply with requirements of the SWPPP, and as described in Section 01 5719, Temporary Environmental Controls.

Soil Profiling and Disposal – Chemically-impacted soil, hazardous waste soil, or regulated waste generated from being in contact with these soil categories (such as decon water) shall be profiled for transport and disposal at facilities permitted to accept such material. Contractor shall conduct soil profiling in accordance with procedures outlined in Article 3.06.

Off-Site Soil Transportation – Chemically-impacted soil and hazardous waste soil shall only be transported off-site by DOT-licensed waste haulers permitted to transport chemically-impacted soil, hazardous waste soil or both. Shipping documents acceptable to receiving facility and in compliance with state and federal requirements shall be used for all soil designated for off-site disposal. Each load must be accompanied by a signed bill of lading or waste manifest as applicable. Each load must be completely covered with a secured tarp or container lid prior to departure.



### **1.06 REQUIREMENTS FOR SOIL CATEGORIES TO BE EXPORTED**

Non-impacted soil, if it is excess and has no use on the work site, can remain in stockpiles stored onsite indefinitely (and if space available) until such time a beneficial use is identified. If non-impacted soil is to be exported, the final destination(s) should be identified in the Contractor's Soil Management Plan. The receiving location(s) shall be described in sufficient detail to confirm that offsite re-use of the non-impacted soil at the receiving location(s) is compliant with all regulatory requirements.

Potentially chemically-impacted soil shall not be exported until such time it is categorized via laboratory analysis as non-impacted, chemically-impacted or hazardous waste soil. Because the final category of potentially chemically-impacted soil is unknown, stockpiles shall not remain stored onsite longer than 90 days unless sampling and subsequent categorization occurs within this timeframe.

Chemically-impacted soil shall not be exported until sufficient laboratory analysis has been conducted to meet the characterization requirements of the receiving facility(s). The receiving facility(s) soil characterization sampling requirements shall be included in the Contractor's Soil Management Plan. Stockpiles of chemically-impacted soil shall not remain stored onsite longer than 120 days from the accumulation start date.

Hazardous waste soil shall not be exported until sufficient laboratory analysis has been conducted to meet the characterization requirements of the receiving facility(s). The receiving facility(s) soil characterization sampling requirements shall be included in the Contractor's Soil Management Plan. Stockpiles of hazardous waste soil shall not remain stored onsite longer than 90 days from the accumulation start date..

All soil categories shall be handled and stockpiled separately from other categories and stockpiles labeled as to which category each belongs. Handling, separate category soil stockpiles, and stockpile labeling shall be maintained until any or all soil categories are prepared to be exported offsite. Preparation for export means all required laboratory analyses, signed bills of lading, signed manifests, properly permitted transporters, and receiving facilities pre-approval are in place.

### **1.07 PERMITS AND FEES**

Obtain and pay for permits and fees required for off-site disposal of the three categories of soil. 1. Non-impacted soil ("clean" excess soil); 2. Chemically- impacted soil; and 3. Hazardous waste soil (see 4.02 for incremental cost reimbursement).

### **1.08 QUALITY ASSURANCE**

Pre-construction Conference: Contractor shall conduct an on-site pre-construction conference to review requirements of this Section before beginning earthwork.

### **1.09 PROJECT CONDITIONS – ENVIRONMENTAL FINDINGS**

The findings of any previous environmental site assessments and soil sampling will be provided by the Authority as an attachment.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS REQUIRED FOR PROPER SOIL STOCKPILING**

Stockpile Sandbags: Fabricate from woven, ultraviolet-resistant materials that are sufficiently close-knit to prevent fines from migrating out through bag with bags tied tightly closed.

1. Burlap bags, if used, shall be lined with plastic.
2. Tires and lined paper bags shall not be used.
3. Sand shall be clean, with 100 percent passing No. 8 sieve.
4. Each bag shall weigh 40 to 60 pounds when filled.

Stockpile Foundation:

1. Existing intact asphalt concrete or concrete pavement.
2. Bare dirt grade condition: Protection to liner shall be at minimum 2 inches of sand on 8 ounce per square yard geotextile over liner.

Stockpile Liners: 60 mil high density polyethylene (HDPE) plastic sheeting, minimum.

Stockpile Covers: 18 mil polyolefin plastic sheeting, minimum.

### **2.02 STORAGE TANKS FOR WATER CONTAINMENT**

Leachate and Stormwater Collection Storage Tanks: Minimum storage tank capacity shall be 20,000 gallons.

Tanks shall have sample ports and drain valves to facilitate characterization and disposal of accumulated liquid.

## **PART 3 - EXECUTION**

### **3.01 NOTIFICATION**

Contractor shall notify the Authority in conformance with this Section, of discovery of potentially chemically-impacted soil, which has been identified by staining, discoloration, odor, free product or a PID reading of 50 ppmv or greater.

### **3.02 SOIL HANDLING**

When working anywhere on the Project Worksite, Contractor shall observe excavated soil for visual signs of staining, discoloration, free product and odors. The Authority, at their own discretion, may also field screen excavated soil by observation as well as screen for the presence of petroleum or other VOCs using a PID calibrated to appropriate standard(s), such as SCAQMD Rule 1166 specifications for VOC screening. Soil exhibiting signs of staining, odor, discoloration or free product or

having a PID reading equal to or greater than 50 ppmv shall be identified as potentially chemically-impacted soil. Contractor shall stop excavation until properly trained personnel are mobilized to Worksite, or continue to segregate and stockpile soil separately from non-impacted soil. As approved by the Authority, Contractor shall continue excavation in this area or shall proceed to stockpile potentially chemically-impacted soil to allow sampling and analysis for soil characterization and to determine the final soil category.

Contractor shall maintain field notes of visual observations, odor detections, PID readings, and locations of these observations and readings.

Contractor shall sample and analyze excess soil that will be exported from Project Worksite for characterization prior to export. Analytical results will be used to determine appropriate re-use or disposal of export material per Article 3.05.

### 3.03 SOIL SEGREGATION AND STOCKPILING

All soil categories: Soil stockpiling activities must conform to sedimentation and erosion control measure requirements as described in Section 32 91 00 Soil Erosion, Sediment Control, Top Soiling and Seeding.

All soil categories: Plastic sheeting shall be secured with sand bags while in storage on the Project Worksite and while being used to cover stockpiles to prevent plastic from blowing into other areas of the Project Worksite.

All soil categories: Due to limitations of the Project Worksite, stockpiling storage space will be limited, and materials shall be exported immediately where possible. Stockpile information and storage durations must be submitted to the Authority and approved by the Engineer.

Non-impacted soil category: Contractor shall separately stockpile and protect in like manner as other soil categories described in Section 3.03, except that stockpile liner, stockpile cover, and special labeling will not be required except to mitigate other conditions, such as fugitive dust or stormwater runoff.

Potentially chemically-impacted soil and chemically-impacted soil categories: Contractor shall stockpile and segregate these two soil categories as follows:

1. Stockpiles shall be placed at locations such that they are protective of surface water bodies and storm drain locations.
2. Potentially chemically-impacted and chemically-impacted stockpiled soil shall be placed on stockpile liner.
3. Potentially chemically-impacted and chemically-impacted soil shall be placed on stockpile liner such that there is a minimum of two feet of excess stockpile liner around sides of stockpile.
4. Seams in stockpile liner shall have a minimum 12-inch overlap.

5. Upon completion of stockpile and at the end of each day, stockpiles shall be covered with stockpile cover.
6. During the workday only the working surface of stockpile shall be uncovered.
7. Each stockpile of potentially chemically-impacted soil shall be labeled with stake or paddle containing an identification number, date stockpile was generated, and words "Potentially Chemically-Impacted Soil." Soil confirmed via laboratory analysis to be contaminated soil, but not hazardous waste soil, shall be labeled to include the words "Chemically-Impacted Soil".
8. At end of each day, document locations of potentially chemically-impacted soil and chemically-impacted soil stockpiles on a site map.
9. Potentially chemically-impacted soil and chemically-impacted soil shall be stored in stockpiles for not longer than 120 days.

Hazardous waste soil category: Contractor shall stockpile and segregate this soil category as follows:

1. Stockpiles shall be placed at locations such that they are protective of surface water bodies or storm drain locations.
2. Hazardous waste soil storage onsite shall not exceed 90 days from the date that accumulation started.
3. Hazardous waste stockpiled soil shall be placed on stockpile liner.
4. Hazardous waste soil shall be placed on stockpile liner such that there is a minimum of two feet of excess stockpile liner around sides of stockpile.
5. Seams in stockpile liner shall have minimum 12-inch overlap.
6. Upon completion of stockpile and at end of each day, stockpiles shall be covered with stockpile cover.
7. During the workday only working surface of stockpile shall be uncovered.
8. Each stockpile of hazardous waste soil shall be labeled with stake or paddle containing EPA ID number, date stockpile was generated, and words "Hazardous Waste Soil."
9. At end of each day, document locations of hazardous waste soil stockpiles on a site map.

### 3.04 MONITORING AND CONTROLS

Monitor air quality continuously during excavation operations at potentially chemically-impacted soil locations, to ensure worker safety and compliance with air monitoring permit requirements.

Implement best available control measures to comply with SCAQMD PM10 emission limits. If necessary, place miniature real-time aerosol monitor (MiniRam) on the prevailing downwind side of the soil excavation area to monitor for airborne particulate emissions during excavation or soil handling activities.

Prevent stormwater runoff from flowing into or out of excavated areas or stockpile areas as described in SWPPP.

Remove, store, sample, characterize, and recycle or dispose of accumulated stormwater and leachate in excavations or stockpile areas. Construct collection sumps at low points and pump to temporary storage tanks at intervals as required to prevent overflow, but not less than weekly.

### 3.05 SOIL PROFILING FOR DISPOSAL

Excess soil for export shall be sampled for proper profiling prior to off-site disposal. Laboratory analysis shall include, at a minimum:

1. Total petroleum hydrocarbons by EPA Method 8015.
2. Volatile organic compounds by EPA method 8260.
3. California Title 22 metals by EPA methods 6010 and 7471.
4. Any additional analytical parameters required by the receiving facility.

Contractor shall sample, analyze, and receive analytical results for soil to establish profile prior to export and disposal.

Contractor's soil samples shall be transported in cooler with ice to a State of California certified environmental laboratory within the laboratory specified holding time. Samples shall remain in cooler with ice. Completed chain-of-custody documentation shall accompany these samples.

Soil identified as hazardous waste soil shall be transported by Contractor off-site for appropriate disposal at an appropriately-permitted facility that is approved by the Authority. Basis for off-site disposal of soil as hazardous waste includes results of soil sample analyses equaling or exceeding California Title 22 Total Threshold Limit Concentrations (TTL) or Soluble Threshold Limit Concentrations (STLC) or US EPA Toxicity Characteristic Leaching Procedure (TCLP) maximum concentrations, where applicable.

In the event additional soil sampling and analyses are required by Contractor's proposed disposal facility for soil profiling and acceptance by disposal facility, Contractor shall perform those additional sampling and analyses as part of disposal.

### 3.06 OFF-SITE DISPOSAL

Hazardous waste materials shall be classified and manifested pursuant to 40 CFR and 22 CCR.

Use transporter(s) identified in letters of commitment and approved by the Authority for off-site transport of hazardous waste. Use of substitute or additional transporters must have previous written approval by the Authority.

Use state-approved manifest system so that hazardous waste hauled from Worksite can be tracked from point of generation to ultimate disposal. Manifests must comply with provisions of state and federal DOT regulations. Use Department of Toxic Substances Control (DTSC) Form 8022A/Environmental Protection Agency Form 8700-22 (Uniform Hazardous Waste Manifest). If receiving disposal site is outside of California, Contractor shall comply also with regulations of the state or states in which materials are being transported to and disposed of. Contractor shall be responsible for providing completed manifests and supporting documentation to the Authority for each load prior to shipment.

Contractor shall be responsible for accurate and timely completion of final waste manifests. Transporters must sign appropriate portions of manifest and must comply with provisions established in state and federal DOT regulations. Disposal facility must sign appropriate portions of manifest and return it to Contractor on day of disposal.

Transport chemically-impacted soil only to off-site disposal/recycling facility approved by the Authority or in the case of hazardous waste soil, only to off-site disposal facility approved by the Authority.

Use appropriate vehicles and operating practices to prevent spillage or leakage of waste materials from vehicles during transport.

Trucks shall be properly lined with material compatible with wastes to be hauled.

Upon completion of truck loading, waste shall be covered with a tarp or container lid prior to departure.

Thoroughly decontaminate and inspect transport vehicles before leaving work area.

Each vehicle leaving work area shall be inspected by Contractor to ensure that no soil adheres to wheels or undercarriage. Remove soil at the work area or decontamination pad before allowing the truck to leave the Worksite.

Remedy situations involving materials spilled in transit or mud and dust tracked off-site. Cost of remedy, including fines, shall be sole responsibility of Contractor.

Coordinate schedule for transport vehicle arrival at Worksite and disposal/recycling facility to meet project schedule. Schedule shall be compatible with soil stockpiling limitations and availability of equipment and personnel for material handling operations.

Contractor is responsible for all permits required for transport of chemically-impacted soil and hazardous waste soil.

### **3.07 NON-IMPACTED EXCESS SOIL DISPOSAL OFF-SITE**

Contractor shall transport non-impacted excess soil to an appropriately licensed off-site disposal/recycling/receiving facility approved by the Authority. Unlicensed facilities, for which Contractor intends to provide non-impacted soil, must be approved by the Authority prior to transporting soil.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

ALLOWANCE – Removal and Disposal of each category of soil, Allowance for [TBD by Project] CY, will be measured by the unit or fraction thereof furnished and completed with the Contract Documents and as measured by the Contractor and verified by the Authority or their designee. Each category of soil will be measured in-situ in cubic yards.

1. UNIT COST – Contractor shall provide unit costs per cubic yard that represent the incremental costs of handling and disposing of the three final soil categories over and above the base cost of earthwork under bid item 31 20 00.01.

The total Allowance shall be for [TBD by Project] CY multiplied by:

2. Incremental Unit Cost per CY for non-impacted soil
3. Incremental Unit Cost per CY for chemically-impacted soil
4. Incremental Unit Cost per CY for hazardous waste soil

### **4.02 PAYMENT**

ALLOWANCE – Removal and Disposal of the three final soil categories will be paid from an allowance included on the approved Schedule of Quantities based on the incremental labor, equipment, and handling costs incurred to dispose of each category of soil over and above normal earthwork. These incremental costs will be measured based on the total volume of each category of soil vs total volume of earthwork.

For example, for 5000 cubic yards of earthwork, if based on laboratory analysis, 20% of the soil was categorized as chemically-impacted, the Authority would pay for 5000 cubic yards of earthwork (paid under bid item 31 20 00.01) and the incremental costs incurred to handle and dispose of 1000 cubic yards of chemically-impacted soil under

this allowance. The incremental costs will be paid based on the Unit Cost provided by the Contractor and will require additional invoicing backup. Contractor will be required to submit documentation of their additional incurred costs of handling and disposing of each category of soil above and beyond the earthwork costs.

**END OF SECTION 31 20 50**



**SECTION 31 50 00**  
**EXCAVATION SUPPORT**

**PART 1 - GENERAL**

**1.1 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. Section 01 33 00 – Submittal Procedures
  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.

## 1.2 REFERENCES

- A. SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria

## 1.3 SUBMITTALS

### A. General:

- 1. Submittals must be made in accordance with Division 01 requirements.

### B. Contractor's Superintendent:

- 1. The Contractor shall 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 Design Criteria Manual, Chapter 15.0, Excavation Support Criteria 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 Design Criteria Manual, Chapter 15.0, Excavation Support Criteria, 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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.

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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.

F. Site Specific Work Plan (SSWP):

1. At least 30 days prior to construction, submit a complete SSWP in accordance with the SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria and Section 01 14 00, Work Restrictions, including, but not necessarily limited to:
  - a. Required Work Windows.
  - b. Construction procedures, materials, equipment and crews).
  - c. Construction schedule.
  - d. Contingency plans.

G. Construction Verification:

1. The Contractor shall submit a letter to SCRRA 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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria. 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 shall 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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.

#### 1.4 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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.
  2. Review and acceptance of submittals by SCRRA 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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria. The Superintendent's qualifications will be subject to review and acceptance by SCRRA.
  2. Excavation or construction of excavation support systems shall not proceed until the Contractor meets SCRRA safety training requirements, obtains a Right-of-Entry agreement (for construction by third parties), and gains acceptance of a SSWP from SCRRA.
  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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria as the Engineer in Responsible Charge for design of the excavation support system.
  4. Review and acceptance of submittals by SCRRA 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.

## 1.5 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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria. 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, permit conditions, and with Division 01 requirements.

## **1.6 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, the approved National Pollution Discharge Elimination System (NPDES) Permit, and 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.

## **1.7 REGULATORY REQUIREMENTS**

- A. Furnish required excavation Plans to jurisdictional authorities and obtain permits as required. Refer to Division 01.

## **PART 2 - PRODUCTS**

### **2.1 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.
- C. Protective Dividers: See Contract Documents and SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.
- D. Handrails and Walkways: See Contract Documents and SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.

- 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 05 12 23 for steel soldier piling and steel sheet piling and Section 34 80 51 for all other structural steel members.
  2. Structural metals other than steel: See Contract Documents.
  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.
  6. Soilcrete: See Contract Documents.
  7. Timber lagging: See Contract Documents and SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.
  8. Ground anchors and rock anchors: See Contract Documents and SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.

## **PART 3 - EXECUTION**

### **3.1 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.

### **3.2 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 SCRRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria and satisfy the contract requirements will be considered for acceptance. Acceptance of alternates will be at SCRRRA'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 SCRRRA as indicated in the SCRRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria 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 SCRRRA, to compensate SCRRRA 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 SCRRRA comments and must be paid regardless of the final disposition (acceptance or rejection) of the alternate design.

### **3.3 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 SCRRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.

4. Provide HMA track underlay for active tracks adjacent to proposed excavations as required in the SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria.
    - 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 RWIC.
  4. Reference the SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria 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 Design Criteria Manual, Chapter 15.0, Excavation Support Criteria 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 Design Criteria Manual, Chapter 15.0, Excavation Support Criteria 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.

### **3.4 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 SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria, and as directed by SCRRA.
  2. Track monitoring data shall be delivered to SCRRA in a format similar to that shown in the SCRRA Design Criteria Manual, Chapter 15.0, Excavation Support Criteria no later than one working day after survey readings are taken.

### **3.5 ACCEPTANCE**

- A. Inspections:
1. Request, schedule and provide the means and access for inspection of the installed excavation support system and finished excavation by SCRRA 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 SCRRA before proceeding with removal and backfilling operations.
- B. Final Acceptance:
1. Apply for and obtain final acceptance from SCRRA, with or without inspection at the sole discretion of SCRRA, 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**

### **4.1 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 31 50 00**

## SECTION 32 12 00

### HOT MIX ASPHALT (HMA) PAVEMENT

#### PART 1 - GENERAL

##### 1.01 SUMMARY

Work covered by this Section includes preparation, placement and compaction of all hot-mix asphalt for roadways, highway-rail grade crossing paving, yards, access roads, miscellaneous surface improvements in RR R/W, temporary improvements, dikes, asphalt overlays, and slurry sealing the existing pavement. Section also includes the prime coat, tack coat, base course and wearing course.

For HMA for Track and Bridges, see Section 34 80 33 – Hot Mix Asphalt (HMA) for Track and Bridges.

- A. 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
  - 6. Section 34 80 33 - Hot Mix Asphalt (HMA) for Track and Bridges

##### 1.02 REFERENCES

- A. Comply with the following Specifications, standards and recommended practices, except as otherwise indicated:
  - 1. SSPWC: Standard Specifications for Public Works Construction current edition, Section 200 Rock Materials, Section 203 Bituminous Materials, and Section 302 Roadway Surfacing
  - 2. SSPWC: Standard Specifications for Public Works Construction current edition, Section 203-5.4 Emulsion-Aggregate Slurry, and Section 302-4.6, Emulsion-Aggregate Slurry.
- 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. See also Section 01 43 23.

### 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.
    - b. Asphalt binder shall be selected based on project location using the Caltrans Pavement Climate Regions Map.

- c. Asphalt binder for Miscellaneous Areas and Dikes shall be PG 70-10 per Caltrans Standard Specifications, Section 92
  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. Asphaltic emulsion for the tack coat shall be of the grade designated by the Engineer.
    - a. The asphaltic 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.
    - a. HMA Pavement – Base Course: Type A with  $\frac{3}{4}$ " maximum, coarse aggregate gradation.
    - b. HMA Pavement – Wearing Course: Type A with  $\frac{1}{2}$ " maximum, coarse aggregate gradation.
    - c. Aggregate for Miscellaneous Areas and Dikes:
      - 1) Type A HMA with  $\frac{3}{8}$ " aggregate gradation.

## 2) Type A HMA with ½" 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, current edition, Section 203-5.4.
- F. Miscellaneous Areas and Dikes: HMA for miscellaneous areas and dikes shall conform to Caltrans Standard Specifications, current edition, Section 39.

**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, current edition, Section 302-4.
- C. Mixing plants shall conform to the requirements of the Caltrans Standard Specifications, current edition, Section 39-3.04 Mixing.
- D. Verify utility locations prior to driving stakes or pins.

- E. Construction procedures and requirements shall conform to Caltrans Standard Specifications, current edition, Section 39-2 Hot Mix Asphalt and SSPWC, current edition, 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 three (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.
- 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, current edition, 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 HMA Pavement, when spread by hand, not in excess of 300 sq yd/hr, per roller.
  - b. 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.
    - 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**

### **4.01 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 Dike and the work is shown on the Plans, full compensation therefore, including any 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 32 12 00**

## SECTION 32 16 00

### CURBS, GUTTERS, AND SIDEWALKS

#### 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. Section 03 21 00 – Reinforcing Steel.
  - 2. Section 03 31 00 – Structural Concrete.

##### 1.02 REFERENCES

- A. Comply with the following Specifications, standards and recommended practices, except as otherwise indicated:
  - 1. SSPWC: Standard Specifications for Public Works Construction 2012, Sections 201-1, Portland Cement Concrete, 201-3, Expansion Joint Filler and Joint Sealants, and 303-5, Concrete Curbs, Walks, Gutters, Cross Gutters, Alley Intersections, Access Ramps, BUS PADS, LOCAL DEPRESSION, CONCRETE APRON, and Driveways.
  - 2. Caltrans: State of California Department of Transportation, Standard Plans Current or Latest Edition.
  - 3. CPUC: General Orders 26D and 118.

##### 1.03 SUBMITTALS

- A. Submit, under provisions of Section 01 33 00, 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.

4. Shop Drawings: Provide scaled drawings of all paving areas indicating proposed types and locations for all joints and pattern of concrete placement. Drawings to include locations of drain inlets, surface utilities and structures. Show proposed sequence for installation of work. Drawings are to be approved by Engineer prior to installation of work.

## **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. Pre-molded joint fillers shall conform to SSPWC Current or Latest Edition, 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 03 31 00.

### **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 32 16 00**

## 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. Caltrans: State of California Department of Transportation, Standard Specifications Current or Latest Edition, Section 84.
  - 2. Caltrans: State of California Department of Transportation, Standard Specifications Current or Latest Edition, Section 85.
  - 3. Caltrans: State of California Department of Transportation, Traffic Manual; California Manual on Uniform Traffic Control Devices, latest edition, Part 3, Chapter 3A and 3B.
  - 4. CCR, Title 24: California Code of Regulations: California State Building Code.

##### 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 Current or Latest Edition 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 32 17 23**

## 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):
  - 1. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 2. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 3. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
  - 4. 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
  - 6. A824, Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for use with Chain-Link Fence.
  - 7. F552, Standard Terminology Relating to Chain-Link Fencing.
  - 8. F567, Standard Practice for Installation of Chain Link Fence.
  - 9. F626, Standard Specification for Fence Fittings.

10. F900, Standard Specification for Industrial and Commercial Steel Swing Gates.
  11. F1043, Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
  12. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- B. 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 SCRRA 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 SCRRA 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 SCRRRA Engineering Standards ES5106.
- E. Corner or Terminal Posts:
  - 1. ASTM F1083 pipe:
    - a. Table 1, Schedule 40, regular grade, in sizes as specified on SCRRRA Engineering Standards ES5106.
- F. Brace and Rails:
  - 1. ASTM F1083 pipe:
    - a. Table 1, Schedule 40, regular grade, in sizes as specified on SCRRRA 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.
2. Materials as specified for fence framework and fabric.
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, clasp 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 32 31 13**

## SECTION 32 31 16

### WELDED WIRE FENCING AND GATES

#### 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
  - 2. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - 3. A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
  - 4. A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
  - 5. A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
  - 6. B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
  - 7. B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
  - 8. D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

9. D2248 Standard Practice for Detergent Resistance of Organic Finishes
  10. D2794 Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
  11. F2408 Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets
- C. SSPWC: Standard Specifications for Public Works Construction Current or Latest Edition Section 304
- D. SCRRRA Engineering Standard ES5105, Right-of-Way Fencing, Welded Wire Mesh Fencing

### **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.
  3. Shop Drawings: Details of fence materials, post spacing, foundations, and anchorage details.

### **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. Clamps: Welded Wire Clamps with tamper proof bolts designed to attached welded wire panels to the post for support and security.

- D. 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. Triangular shaped stiffening beam shall be placed horizontally and face away from track, or from the public side of sidewalks.
- C. Posts shall be installed at 10 feet intervals in accordance with ES5105 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.
- E. Use tamper resistant bolts to secure welded wire mesh panels to posts via line wrap around brackets.

### **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.
- A. 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.
- B. 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.
- C. 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.

**4.02 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 32 31 16**

## 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. This work also includes providing locks, keys and emergency access system.
- B. Coordinate the work of this Section with all other Sections of this Specification and, in particular:
  - 1. 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
  - 2. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - 3. A153 Standard Specification for Zinc Coating (Hot-dip) on Iron and Steel Hardware
  - 4. A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - 5. A787 Standard Specification for Electric-Resistance-Welded Metallic Coated Carbon Steel Mechanical Tubing
- C. SCRRRA Engineering Standard ES5102, Right-of-Way Fencing, Welded Wire Mesh Fencing and ES5104, Right-of-Way Fencing, Tube Steel Fencing.

##### 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: Pickets shall be galvanized, 1-inch square tubular steel members, 11 gauge minimum, conforming to ASTM A787, 45,000 psi yield strength, and G90 zinc coating. Picket spacing shall be 4 inches maximum center to center.
- B. Panel height: Finished fence height shall be 6 feet for Inter-Track fence and 3'-2" feet at platform edge fence. Panel width shall be as per SCRRA Engineering Standards ES 5102 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-Polyester 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.
- C. 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.
- D. Fence top extension shall face away from the track.
- E. Posts shall be installed at 10 feet intervals in accordance with SSPWC 2009 Section 304-3 for installation of posts.
- F. 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.

**4.02 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 32 31 19**

## SECTION 32 31 32

### VEHICULAR GATE OPERATOR SYSTEM

#### 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**

- A. Vehicular swing gate and slide gate operator shall be in compliance with Underwriter Laboratories Inc. (UL) Standard for Safety - Door, Drapery, Gate, Louver and Window Operators and Systems, UL 325 Fourth Edition; and Underwriters Laboratories Inc. (UL) Standard for Safety - Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 Second Edition.
- 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 be 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 32 31 32**

## 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.
- B. Contractor shall prepare and submit a wall layout drawing that depicts the wall layout and section developed with input from manufacturer recommendation.

#### PART 2 - PRODUCTS

##### 2.01 MATERIALS

- A. Approved retaining wall systems, meeting these specifications are:
  - 1. Enviro-Block by inter-Block Retaining Systems, Valley Center, CA. Telephone: 800-406-2066

2. Keystone Retaining Wall Systems, 4444 West 78th Street, Minneapolis, MN 55435 - Telephone 952-897-1040 or keystone@kestonewalls.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, unless noted otherwise.
  - 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 Mirafi "Filterweave 404" or approved equivalent.

## **2.02 ACCEPTANCE OF BLOCKS**

- A. Acceptability will be determined based on tolerances specified in 2.01 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, misshapen, or deformed blocks
  2. Honeycombed or open texture concrete
  3. Broken, cracked or chipped blocks
  4. Extreme color variation on visible face of block

## **2.03 DELIVERY, HANDLING, AND STORAGE**

- A. Contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification have been received.
- B. Contractor shall protect all materials from damage due to jobsite conditions in accordance with manufacturer's recommendations.
- C. Damaged materials shall not be incorporated into the work.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Excavate existing material in accordance with Section 31 20 00 as needed to construct the wall as detailed on the plans.
- B. Prepare the subgrade in accordance with Section 31 20 00 and suppliers recommendations.

### **3.02 GRAVITY BLOCK RETAINING WALL CONSTRUCTION**

- A. Preparation
  - 1. 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.
  - 2. The zone of over excavation shall be backfilled with Class 2 Crushed Aggregate Base conforming to Section 34 11 27. 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.
  - 3. 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.
- B. Block Installation and Backfill Placement
  - 1. 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.
  - 2. Place the first course of blocks on top of and in full contact with the prepared base pad surface.
- C. Install drain pipe filter fabric and pervious rock in accordance with the plans and Section 33 46 00.

- D. 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.
- E. 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.
- F. Maximum horizontal gap shall be plus or minus 1 inch.
- G. Grade embankment at top of wall in accordance with the plans.
- H. Install fencing as indicated on the plans.

### **3.03 GRAVITY BLOCK WALL CONSTRUCTION (SMALL BLOCKS)**

- A. Prepare subgrade in accordance with manufacturer's recommendations, at minimum over excavate and compact 6 inches below leveling pad.
- B. Place leveling pad as indicated on manufacturer's drawings or as called for in plans or specifications.
- C. Walls shall be installed in accordance with manufacturer's shop drawings and standard details, with the addition of geotextile fabric as described above
- D. Grade embankment at top of wall in accordance with the plans.
- E. Install fencing as indicated on the plans.
- F. Maximum horizontal gap shall be plus or minus ½ inch.

## **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, precast 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 block 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 32 32 16**

## 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/f<sup>3</sup>)(600 kN-m/m<sup>3</sup>)
  - 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/f<sup>3</sup>) (2700 kN-m/m<sup>3</sup>)
  - 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

11. D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
12. D4491 Standard Test Method for Water Permeability of Geotextiles by the Permittivity Method
13. D4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
14. D4873 Standard Guide for Identification, Storage and Handling of Geosynthetics
15. D5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
16. D5262 Standard Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics
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
19. D6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
20. D6638 Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units
21. D6706 Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
22. F405 Standard Specification for Corrugated Polyethylene (PE) Tubings and Fittings
23. G51 Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing
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

28. A497/A497M Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
  29. A370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products
- D. Federal Highway Administration
1. Elias, V., Christopher, B., and Berg, R., "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines", Federal Highway Administration Report No. FHWA-NHI-00-043, March 2001.
  2. Elias, V., Christopher, B., and Berg, R., "Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes", Federal Highway Administration Report No. FHWA-NHI-00-044, March 2001.
- 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 California 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 California 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. The Authority 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 Contract Documents.
- 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. 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)
2. 1.5 against sliding of the mass
3. 2.0 against overturning of the mass
4. 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  $\frac{1}{4}$  inch. All hardware embedded in the panel with the exception of attachment devices shall be within  $\frac{1}{4}$  inch.
  - c. Panel Squareness - Squareness, as determined by the difference between the two diagonals, shall not exceed  $\frac{1}{2}$  inch.
  - d. Panel Surface Finish - Surface defects on smooth-formed surfaces, measured on a length of 5 feet, shall not exceed  $\frac{1}{4}$  inch. Surface defects on textured-finished surfaces, measured on a length of 5 feet, shall not exceed  $\frac{5}{16}$  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:

<b>Gradation Requirements</b>		
<b>Sieve Size</b>	<b>Percentage Passing</b>	<b>California Test</b>
6"	100	202
3"	78-100	202
No. 4	----	202
No. 30	0-60	202
No. 200	0-15	202

<b>Property Requirements</b>		
<b>Test</b>	<b>Requirement</b>	<b>California Test</b>
Sand Equivalent	12 minimum	217
Plasticity Index	6 maximum	204
Minimum Resistivity	2000 ohm-cm	643
Chlorides	< 250 ppm	422
Sulfates	< 500 ppm	417
pH	5.5 to 10.0	643

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:

<b>Gradation Requirements</b>		
<b>Sieve Size</b>	<b>Percentage Passing</b>	<b>California Test</b>
2"	100	202
No. 4	50-80	202
No. 40	0-30	202
No. 200	0-15	202

<b>Property Requirements</b>		
<b>Test</b>	<b>Requirement</b>	<b>California Test</b>
Sand Equivalent	30 minimum	217
Plasticity Index	6 maximum	204
Durability Index	35 minimum	229
pH	4.5 to 9.0	643

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:



<b>Property Requirements</b>		
<b>Test</b>	<b>Requirement</b>	<b>California Test</b>
Minimum Resistivity	2000 ohm-cm	643
Chlorides	< 250 ppm	422
Sulfates	< 500 ppm	417
pH	5.5 to 10.0	643

7. Permeable material for earth retaining structures with geosynthetic soil reinforcement shall conform to the following requirements:

<b>Property Requirements</b>		
<b>Test</b>	<b>Requirement</b>	<b>California Test</b>
pH	4.5 to 9.0	643

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.
14. Adhesive for bonding filter fabric to concrete panels shall be commercial grade.

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 - EXECUTION**

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-I.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.
- 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.

**END OF SECTION 32 32 20**

## SECTION 32 80 00

### IRRIGATION SYSTEM

#### 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. Complete installation of irrigation pipes and accessories for a complete sprinkler system including trenching, backfilling, valves, controllers, valve boxes, connections to existing electrical supply, water supply, cutting and patching as necessary.
  - 2. All hose bibs and quick couplers necessary.
  - 3. Protect all existing utilities and repair any damage to existing utilities with matching new materials, at no increase in contract price.
  - 4. As-built drawings showing the piping schematic and layout.
  - 5. Clean-up.
  - 6. 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" drawings which shall show the exact "as-built" locations, sizes, and kinds of equipment. This set of drawings shall be kept up to date 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. Routing of control wiring
    - g. Quick coupling valves
    - h. Other related equipment



3. 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 32 80 00**



## **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
3. Furnish and planting of plant material as required by the Contractor's design submittal.
4. Staking and protecting trees and plantings
5. Maintenance of plants and planting for a minimum of 90 calendar days after completion and acceptance of the work
6. 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 REFERENCES**

- A. SCRRA Design Criteria Manual Chapter 26, Landscaping Design Criteria

##### **1.03 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.

#### 1.04 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.

#### 1.05 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 naphthenate.

- 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 32 90 00**

## 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.
  - 3. Seeding.
- 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.
- B. California Stormwater Quality Association (CASQA), "BMP (Best Management Practice) Handbook Portal ([www.casqa.org](http://www.casqa.org)) – Construction".
- C. ASTM International (ASTM):
  - 1. D586, Standard Test Method of Ash in Paper.
- D. Caltrans Standard Specifications 2010.

##### 1.03 QUALITY ASSURANCE

- A. Certifications:
  - 1. Association of Official Seed Analysts – Seed Laboratory Certification.
  - 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:

Botanical Name	Common Name	Pounds/ Acre	Purity / Germination
Artemisia California	California Sage Brush	4	50/15
Encelia California	Bush Sunflower	3	60/40
Eschscholzia California	California Poppy	2	75/98
Lotus Scoparius	Deerweed	8	60/90
Eriogonum fasciculatum	California Buckwheat	8	65/10
Lasthenia glabrata	Goldfields	2	85/90
Lupinus Succulentus	Arroyo Lupine	4	85/90
Eriophyllum confertiflorum	Golden Yarrow	3	60/30
Salvia apiana	White Sage	4	50/70
Sisyrinchium bellum	Blue-Eyed Grass	1	75/95
Diplacus longiflorus	Monkey Flower	2	55/2
Salvia mellifera	Black Sage	4	50/70
Stipa pulchra	Purple Needlegrass	2	70/60
Bromus arizonicus	Cucamonga Brome	5	95/80
Melica californica	California Melic	3	90/60
TOTAL POUNDS PER ACRE		55	
<i>Slurry Mix</i>			
	Fiber	2000	
	Organic Soil Stabilant (Tackifier)	140	

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:

Property	Test	Value	
		Woven	Nonwoven
Grab breaking load, 1-inch grip, lb min, in each direction	ASTM D 4632	120	120
Apparent elongation, percent min, in each direction	ASTM D 4632	15	50

Water flow rate, gal per minute/sq ft min and max average roll value	ASTM D 4491	10–100	100–150
Permittivity, sec <sup>-1</sup> min	ASTM D 4491	0.1	1.1
Apparent opening size, inches max average roll value	ASTM D 4751	0.023	0.023
Ultraviolet resistance, percent min retained grab breaking load, 500 hours	ASTM D 4355	70	70

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.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Prior to General Stripping Topsoil and Excavating:
  - 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 32 19 00**



## **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. Section 31 20 00 - Earthwork.
  - 2. Section 31 50 00 - Excavation Support.
  - 3. Section 33 05 23 – Steel Casing (material requirements)
  - 4. Section 34 11 26 - Ballast.
  - 5. Section 34 72 00 - Trackwork.

##### **1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA): Manual for Railway Engineering.
- B. SCRRRA Engineering Standard Drawings: Particularly, but not limited to ES5001 and ES5002.
- C. SCRRRA Standard Specifications Section 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 feet for non-flammable substances in the carrier pipe and five 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 Section 01 33 00, 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 01 33 00 and 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 SCRRA 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 Authority or replaced at no additional cost to the Authority.
- 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 Authority.
- J. Operations shall be stopped if ground displacement is detected.
  - 1. The Contractor must employ the emergency remediation plan approved by the Authority 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 SCRRRA forces or shall be taken by the Contractor as approved by the Authority.
  - 4. SCRRRA 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 Authority, 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 whichever is greater.
- N. Provide vents if so indicated in ES5002 or 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 Authority.
  - 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 33 05 23**

## SECTION 33 42 00

### CULVERT AND DRAINAGE PIPE

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Culverts.
    - a. Headwalls
    - b. Flumes
    - c. End sections
  - 2. Storm drainage systems.
    - a. Headwalls
    - b. Storm drain pipe
    - c. Cleanouts
    - d. Connections
    - e. Risers
  - 3. Storm Drain Appurtenances
    - a. Concrete collars
    - b. Brick and mortar plugs
    - c. Concrete Caps
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 31 11 50 - Demolition, Cutting and Patching.
  - 2. Section 31 20 00 - Earthwork.
  - 3. Section 31 50 00 – Excavation Support
  - 4. Section 33 05 23 - Steel Casing.
  - 5. Section 34 11 27 - Sub-Ballast and Aggregate Base.



6. Section 03 31 00 - Structural Concrete.
7. 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.
  2. A48, Standard Specifications for Gray Iron Castings.
  3. A760, Corrugated Steel Pipe, Metallic Coated for Sewers and Drains.
  4. A761, Corrugated Steel Structural Plate, Zinc-Coated, for Field –Bolted Pipe, Pipe-Arches, and Arches.
  5. A780, Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
  6. B633, Coating.
  7. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
  8. C150, Standard Specifications for Portland Cement.
  9. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
  10. C1784, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe.
  11. D2729, Standard Specification for Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
  12. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Material.
- 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, Storm Drains, and Underdrains.

2. Chapter 1, Part 4, Section 4.5, Standard Specification for Corrugated Aluminum Alloy Pipe.
  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.
- D. Standard Plans for Public Works Construction (SSPWC) "Green Book", Current or Latest Edition.
- E. Standard Specifications for Public Works Construction (SSPWC) "Green Book", Current or Latest Edition.
- F. State of California Department of Transportation "Caltrans" Standard Plans and Specifications, Current or Latest Edition.

### 1.03 SUBMITTALS

- A. General:
1. Submittals shall be made in accordance with Section 01 33 00 requirements.
- B. Plans and Procedures:
1. Piping Layout Plans for approval by the Authority.
  2. Schedules of work.
  3. Design calculations for culverts not constructed in accordance with SCRRA Engineering Standard Plans.
    - a. 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:
    - a. Acknowledgement that products submitted meet requirements of standards referenced.
  2. Certifications:

- a. Crushed Stone Bedding Material meeting gradation requirements of Section 34 11 27.
  3. Test reports:
    - a. 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.
    - a. Test results submittal shall be on a form approved in advance by the Engineer.
    - b. Test results shall be organized by culvert or drainage structure.
    - c. 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 SCRRA field location of underground utilities prior to starting any excavation work.

#### **1.04 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 Authority 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.

**1.05 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 and those areas impacted by construction 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.

**1.06 REGULATORY REQUIREMENTS**

- A. 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. Prefomed flexible pipe joint sealing compound:
    - a. RAM-NEK.
    - b. BIDCO C-56.
    - c. Or equal.
- B. Submit request for substitution in accordance with Division 01.

**2.02 MATERIALS**

- A. Reinforced Concrete Pipe (RCP):

1. RCP shall not be used, unless approved by the Authority, when crossing below tracks and within the typical track section with 2:1 side slopes. If placed under the track, the pipe shall be able to withstand railroad loading.
  2. Reinforced concrete culvert, storm drain and sewer pipe: RCP Joint Sealer:
    - a. Rubber gasket: ASTM C361 when water tight joints indicated in the Plans.
    - b. Joint sealing material per Article 2.01 above for other joints of concrete pipe.
  3. Flared End Sections:
    - a. 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:
    - a. Minimum cover and gage shall be per the SCRRA Engineering Standards.
    - b. CMP shall be coated in accordance with AASHTO M274, Steel Sheet, Aluminum Coated (Type 2), for corrugated metal pipe.
    - c. CMP over 48 inches diameter shall be fabricated with a 5 percent elongation in the vertical direction.
    - d. 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.
- e. 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:
- a. 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 SCRRA Engineering Standards.
4. Jointing and End Finish:
- a. Corrugated connecting bands of same base metal, corrugations and finish coating as pipe.
  - b. Connection bands shall conform to Section 66-1.02D of the Caltrans Standard Specifications.
  - c. Thickness shall conform to gage shown in Table 2 – Round Corrugated Steel Pipe (CSP) contained on the SCRRA Engineering Standards.
  - d. 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:

- a. Cold applied asphalt joint compound.
    - b. 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:
    - a. Comply with Section 34 80 32.
    - b. Concrete and Reinforcement for Inlets, Headwalls, Flumes and End Sections shall conform to SCRRRA 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.
    - a. It must be installed in a steel casing meeting requirements of Specification Section 33 05 23 and SCRRRA 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 diameter 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 diameter..
- 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 SCRRRA Engineering Standards ES6003 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 00 and Section 31 11 50.
- 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 Authority in accordance with these Specifications or replaced at no additional cost to SCRRRA.
  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.
    - a. Other drainage pipes use bedding material as shown in the Plans or as detailed in these specifications.
    - b. 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:
    - a. 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.
    - b. 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.
    - c. 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:
    - a. 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.

- b. 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.
- c. 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.
- d. Pipe-arches shall not be strutted.
- e. Identification tag, supplied by manufacturer, shall be attached near top of and inside of pipe at upstream end.
- f. 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 1**

<b>CMP Pipe Diameter - Inches</b>	<b>Base of Tie to Top of Pipe - Feet</b>
48	3.5
54 to 66, incl.	4.0
72 to 96, incl.	4.5
102 to 108, incl.	5.0
114 to 120, incl.	5.5

- g. 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.
  - h. 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.
  - i. Unless otherwise directed by the Engineer, struts shall be left in place until track laying is completed after which the struts shall be removed.
  - j. The furnishing and placing of field strutting material shall be considered incidental to pipe placement.
3. Reinforced Concrete Pipe.
- a. Installation shall be in accordance with AREMA Manual For Railway Engineering Chapter 8, Part 10.4, Installation.
  - b. Gaskets out of position or loaded with dirt or other foreign material shall be removed, cleaned, and replaced before the joint is made.
4. Polyethylene and PVC Pipe:
- a. Install in accordance with the manufacturer's written recommendations and as shown in the Plans.
5. Structural Plate Pipe:
- a. Structural plate pipe shall be erected at the site, in accordance with detailed plans or instructions of the Engineer.
  - b. 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.
  - c. 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.

- d. Strutting of structural plate pipe, if required, shall be as shown in the Installation Procedures or Erection Diagram.
  - e. 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.
  - f. Where heavy camber is necessary, erection procedures may be modified, but only as specifically approved by the Engineer for each such case.
  - g. 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.
  - h. Identification tag, supplied by manufacturer, shall be attached near top of and inside of pipe at upstream end.
  - i. 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.
  - j. 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:

- a. 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.
  - b. 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:
- a. 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.
  - b. 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.
  - c. 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.
  - d. 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.
  - e. 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.

- f. 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.
  - g. 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 SCRRA 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 SCRRA.
  - 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 33 42 00**



## **SECTION 33 46 00**

### **UNDERDRAINS**

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

##### **1.1 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. Section 31 20 00 - Earthwork.
  - 2. Section 31 50 00 - Excavation Support and Protection.
  - 3. Section 34 80 23 - Subdrainage System for Railroad Bridges and Retaining Walls.
  - 4. Section 33 42 00 - Culvert and Drainage Pipe

##### **1.2 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)
  - 1. D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- D. Caltrans: State of California Department of Transportation Standard Plans and Specifications, 2018 Sections 19, 68, and 96.
- E. Standard Plans for public Works Construction (SSPWC) “Green Book”, 2012.
- F. SCRRRA: Engineering Standards.

### 1.3 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 reference to high-density polyethylene (HDPE), or to Polyvinyl Chloride (PVC) as noted in the Contract Plans.
- 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 ballast material as indicated in Part 2 of Section 31 11 26 of the Standard Specifications.

### 1.4 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.

### 1.5 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.
  - 2. Perforated pipe sample shall show full pattern of perforations.

## PART 2 - PRODUCTS

### 2.1 BEDDING MATERIALS

- A. Sand bedding shall conform to Caltrans Section 19-3.02F(2).

### 2.2 PERMEABLE BACKFILL MATERIAL

- A. Permeable backfill material shall conform to Caltrans Section 68-2.02F(4), Class 3.

### **2.3 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). same material and from the same manufacturer as the plastic pipe.
- B. 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 Volume 1. Chapter 1, Section 4.3.3.2 of the AREMA manual.

### **2.4 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.
- B. Elements in rail loading zone shall be specified to withstand rail loading.

### **2.5 GEOTEXTILE**

- A. Geotextile shall conform to Caltrans Standard Specifications Section 96-1.02.

### **2.6 UNDERDRAIN GRANULAR BACKFILL**

- A. Underdrain Granular Backfill Material: Backfill material for underdrains located within ballasted track areas shall be  $\frac{3}{4}$ -inch round river rocks. Backfill for underdrains located outside ballasted track areas shall conform to the pervious backfill requirements of Caltrans Standard Specification 19-3.065.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Preparation of site for the installation of underdrains shall be in accordance to Part 3.01 of Section 33 42 00 of these Specifications.

### **3.2 HANDLING OF MATERIAL**

- A. Handling of underdrain materials shall be in accordance to Part 3.02 of Section 33 42 00 of these Specifications.

### **3.3 EXCAVATION AND EXCAVATION SUPPORT**

- A. Excavation and excavation support shall be in accordance with Section 31 50 00 and Section 31 20 00.

- B. 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 the Authority.
- C. Subgrade shall not be compacted below Underdrain.

### 3.4 UNDERDRAIN INSTALLATION

- A. Preparation of Trench Bottom
  - 1. Excavate trench bottom to an elevation 6 inches below bottom of pipe.
  - 2. Fill trench bottom to the bottom of pipe grade with underdrain granular backfill material to ensure complete and continuous support for the barrel of the pipe.
  - 3. Excavate bell holes to size necessary to accommodate joint.
- B. 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.
- C. Place 6 inches of permeable rock on the filter fabric. Grade the rock to the line and grade indicated for the perforated drainpipe.
- D. 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.
- E. Installation of ballast material as for bedding material should be per the limits as shown in the Contract Plans.
- F. Lay pipes in the upstream direction to the lines and grades shown, with the bell pointing upgrade.
- G. 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.
- H. 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.
- I. Complete permeable rock backfill as indicated and close the filter fabric at the top of this backfill with 12 inches lap.

- J. Place and compact structural backfill in accordance with Section 31 20 00. Exercise caution not to damage the filter fabric and sheet drain material.

### **3.5 FIELD QUALITY CONTROL**

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

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.1 MEASUREMENT**

- A. Underdrains 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 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.
- C. Trench excavation and export, trench preparation, underdrain installation and compaction are incidental to the work and will not be measured separately for payment.
- D. Filter fabric including overlap, permeable rock and fill material are incidental to the work and will not be measured separately for payment.

### **4.2 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.
- C. Trench excavation and export, trench preparation, underdrain installation and compaction are incidental to the underdrain pipe and will not be a pay item.
- D. Filter fabric, including overlap, permeable rock and fill material are incidental to the work and will not be a pay item.

**END OF SECTION 33 46 00**

**SECTION 34 11 10**  
**CONTINUOUS WELDED RAIL**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section specifies the material requirements and performance criteria for the Continuous Welded Rail (CWR) to be furnished in accordance with Contract Documents or required by the Engineer.

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering
  - 2. Portfolio of Trackwork Plans
  - 3. Specifications for Special Trackwork
- B. Association of American Railroads (AAR)
  - 1. AAR: Manual of Standards and Rec. Practices
  - 2. AAR Section J: Quality Assurance M-1003
- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM E10: Test Method for Brinell Hardness of Metallic Materials
  - 2. ASTM E94: Recommended Practice for Radiographic Testing
  - 3. ASTM E164: Standard Practice for Ultrasonic Contact Examination of Weldments
- B. American Welding Society (AWS):
  - 1. AWS B2.1: Standards for Welding Procedures and Performance Qualifications
  - 2. AWS D1.1: Structural Welding Code
- C. SCRRRA: Engineering Standards.

**1.03 DEFINITIONS**

- A. Detail Fractures – A progressive fracture originating near the rail surface from a shell or head check

- B. Rail Wear – The change in shape of the cross-sectional area of the rail head due to the passage of rail traffic and grinding
- C. Shelling – A rail condition consisting of one or more horizontal separation that may originate in the rail head and may crack out at the gage side of the rail. Shelling normally originates towards the gage side of the rail head and extends longitudinally
- D. Spalling – A rail surface condition that is the direct result of micro-cracking, often with material separating from the surface of the rail head.

#### **1.04 SUBMITTALS**

- A. The CWR Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the CWR have been placed in service.
- B. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing CWR to Class 1 Freight, passenger or commuter railroads.
- C. The Vendor shall submit for SCRRA's review and approval quality control and quality assurance plans and related certifications such as ISO 9001, "six sigma" or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality CWR included in the Schedule of Quantities and Prices.
- D. The Vendor shall submit certification that materials delivered to site are in conformance with specifications. For CWR, include weld test results. Include all material testing results and submittals stipulated in the AREMA Manual.
- E. The Vendor shall submit procedure for transportation of CWR to site, unloading and handling.
- F. Prior to the start of welding, submit a schedule of lengths of CWR strings to be fabricated and the location of each string in the delivery train. Rail is to be delivered by train, if other delivery is intended submit such to the Authority for approval.
- G. The Vendor shall submit drawings and specifications of the proposed equipment, materials, methods and procedures to be used for the electric flash butt welding process for joining of rail. Include layouts of the welding line showing locations of welding components.
- H. The Vendor shall submit qualifications of welding supervisor demonstrating flash butt welding experience of no less than three years.

**1.05 QUALITY ASSURANCE**

- A. Vendor's Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRRA approved equivalent quality control program. Comply with AREMA Portfolio of Trackwork Plans.
- B. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.
- C. Testing and inspection of CWR manufacture shall be performed by CWR Vendor in conformance with AREMA Manual.
- D. Material not meeting the requirements of this Specification shall not be used.
- E. SCRRRA shall have access to CWR Vendor's plant during normal working hours and all Project related procurement and production records for inspection any time during the Contract period of performance.

**1.06 DELIVERY, STORAGE AND HANDLING**

- A. The CWR Vendor shall load, transport, and deliver CWR in a manner which will prevent damage to the CWR. Vendor shall submit to SCRRRA the procedures and equipment information for loading, unloading, handling, and storing rail.
- B. SCRRRA will review the Vendor's methods and procedures for unloading and handling continuous welded rail.
- C. The material will be supplied to the SCRRRA in accordance with the delivery requirements. Quantity of each supply will be as requested by the SCRRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRRA. The delivery must be coordinated with SCRRRA prior to shipping and loading. Orders can be combined and shipped on or before the delivery scheduled with approval by SCRRRA. Delivery time and minimum quantities shall be as follows:
- D. Delivery delays due to Rail Train (carrier) unavailability are excusable when the Vendor has made a best efforts attempt to schedule a carrier, and these best efforts, at minimum included 14 days advance communication with at least three carriers. Documentation of these best efforts and approval is required by SCRRRA.

**PART 2 - PRODUCTS****2.01 CWR**

- A. Rail shall be new 136 RE CWR Head Hardened rail conforming to AREMA Volume 1, Chapter 4, Section 2.1, Specifications for Steel Rails. The rail shall be controlled cooled low alloy high strength rail, Grade HH (Head Hardened) or LH (Low Alloy Head Hardened) and shall meet or exceed 370 HB (Brinell Hardness).



- B. If the Vendor furnished CWR are in sections of strings, CWR shall be manufactured on-site by welding rail sections in nominal 80 feet length into 1,400 feet strings, or into such lengths as are suitable to the project and as approved by the Authority.

## **2.02 SOURCE QUALITY CONTROL**

- A. Rail and welds shall be ultrasonically tested as per AREMA Section 2.1 8.
- B. Surface and internal hardness shall be determined as per AREMA Section 2.1.3.
- C. Perform ultrasonic testing on all welds in accordance with ASTM E164.
- D. For fabrication of CWR, flash butt production welds shall be tested by an inspection agency approved by the SCRRA during the fabrication process using the dry powder method of magnetic particle inspection (or ultrasonic method) in accordance with ASTM E709 and the AREMA Manual of Railway Engineering, Chapter 4.

## **2.03 SPECIFICATIONS, SECTION, AND STANDARDS**

- A. Unless otherwise shown on the drawings or listed in the Schedule of Quantities and Prices, rail shall conform to the 136 RE section shown on SCRRA Engineering Standard ES 2301.

## **2.04 MANUFACTURE**

- A. Melting and Casting:
  - 1. The steel for rails shall be made by purifying molten iron from the blast furnace (plus any added scrap steel) using the Basic Oxygen Steelmaking process, or by melting scrap steel using the Electric Arc Furnace Steelmaking process. The resulting molten steel from either process shall be cast into strands by a continuous casting process. Strands shall be cut into blooms of an appropriate length for further processing and rolling.
- B. Hydrogen Elimination:
  - 1. The rail shall be free from shatter cracks and other inclusions caused by hydrogen. Hydrogen elimination shall be accomplished by at least one of the following processes:
    - a. Control Cooling of Rails (CC)
    - b. Control Cooling of Blooms (BC)
    - c. Vacuum Treated (VT)
  - 2. Other processes (OP) for hydrogen and inclusion elimination in steel shall be accepted in the production of steel rail, and be approved by SCRRA.

3. When controlled cooling of rails is used for elimination of hydrogen, all rails shall be cooled on the hot beds or runways until full transformation is accomplished and then charged immediately into insulated cooling containers. In no case should the rail be charged into the containers at a temperature below 725 degrees F. The temperature of the rails before charging shall be determined at the head of the rail at least 12 inches from the end of the rail.
4. A cover shall be placed on the container immediately after completion of the charge and shall remain in place for at least 10 hours. The container shall be so protected and insulated that the control temperature shall not drop below 300 degrees F in 7 hours for rails 100 lbs. per yd. in weight or heavier from the time the bottom tier is placed in the container and 5 hours for rails of less than 100 lbs. per yd. in weight. The control temperature shall be established by measuring and recording the temperature of an outside rail or between an outside rail and the adjacent rail in the bottom tier of the container, at a location not less than 12 inches but not more than 36 inches from the rail end.
5. If the above cooling requirement is not met, the rails may be considered control-cooled, provided that the temperature at a location not less than 12 inches from the end of a rail at approximately the center of the middle tier does not drop below 300 degrees F in less than 15 hours.
6. After removal or raising of the lid of the container, no rail shall be removed until the temperature of the top layer of rails has fallen to 300 degrees F or lower. The manufacturer shall maintain a complete record of the cooling process for each container of rails.

## 2.05 CHEMICAL AND MATERIAL PROPERTIES

### A. Chemical Composition:

The chemical composition of a rail steel grade must be within the limits given in **Table 1** for standard chemistry rail steel. Rail steel with a high carbon content in a range from 0.9 to 1.1 percent by weight and chemistry similar to that disclosed in United States Patent No. 7,288,159 is also acceptable provided that rail rolled this specification has been in successful use for more than five years by a Class I railroad operating in North America.

**Table 1: Product and Chemical Analysis Table for Standard Chemistry Rail Steel**

Elements	Notes	Chemical Analysis Weight Percent		Product Analysis, Weight Percent Allowance Beyond Limits of Specified Chemical Analysis	
		Minimum	Maximum	Under Minimum	Under Maximum
Carbon	1	0.740	0.860	0.040	0.040
Manganese		0.750	1.250	0.060	0.060
Phosphorus	2		0.020		0.008
Sulfur	3		0.020		0.008
Silicon		0.100	0.600	0.020	0.050
Nickel			0.250		
Chromium	1		0.300		
Molybdenum	1		0.060		
Vanadium			0.010		
Aluminum			0.010		
Other	4				
Note 1: The chemical composition of head-hardened rails will be subject to the requirements of standard strength rails Any alteration of the chemical composition may require modification of welding procedures.					
Note 2: Up to 5% of the order may exceed 0.020, but in no case may the phosphorus exceed 0.025					
Note 3: Up to 5% of the order may exceed 0.020, but in no case may the sulfur exceed 0.025.					
Note 4: Additional elements may be included in the chemistry and the chemical analysis when agreed upon by the purchaser and supplier.					

**B. Surface Hardness:**

Rails furnished shall be high strength or high carbon pearlite. The minimum Brinell hardness of the surface shall be within the limits found in Table 2.

**Table 2 – Rail Hardness Table for Standard Chemistry Rail Steel**

Type of Rail	Minimum Surface Brinell Hardness, HB
High Strength Rail	370
High Carbon Pearlite (Patent No. 7,288,159)	390
Note 3: If 410 HB is exceeded, the microstructure through the head shall be examined at 100X or higher for confirmation of a fully pearlitic microstructure in the head.	

Note 4: No untampered martensite shall be present within the rail.

A fully pearlitic microstructure shall be maintained in the head of the rail for all ranges of rail chemistry and no un-tempered martensite may be present within the rail at any point of the rail section.

C. Tensile Properties:

The tensile properties of rails shall be produced within the limits found in Table 3 for a particular grade of rail steel.

**Table 3 – Tensile Properties Table for Standard Chemistry Rail Steel**

Description	High-Strength	High Carbon Pearlite (United States Patent No. 7,288,159)
Minimum Yield Strength	120,000 psi	120,000 psi.
Minimum Tensile Strength	171,000 psi	174,000 psi
Minimum Elongation in 2 in.	10% <sup>1</sup>	10%
Note 1: Up to 5% of the order may be less than 10% elongation for high-strength rail, but in no case may the elongation be less than 9%		

**2.06 ROLLING, CUTTING, AND PREPARING RAIL ENDS**

A. Rolling:

The length of rails for welding into CWR strings shall be not less than 80 feet when corrected to a temperature of 60 degrees F. Not more than 10 percent of standard length rail of the total tonnage accepted from each individual rolling may be comprised of shorter lengths corresponding to 78, 74, 70, 66, 60, or 39 feet.

Individual rails not welded into CWR strings as part of the purchase shall be furnished to the length shown on the Schedule of Quantities and Prices. The allowance for 10 percent shorter lengths will not apply to individual rails ordered to a specific length.

B. Straightening:

Rails shall be straightened cold in a press or roller machine to remove twists, waves and kinks until they meet the surface and line requirements within the tolerances specified.

C. Drilling:

Rails to be welded into CWR strings shall be furnished undrilled (blank). Individual rails not welded into CWR strings shall be furnished to SCRRA undrilled but chamfered and finished on both ends in accordance with SCRRA Engineering Standard No. ES 2301.

## 2.07 IDENTIFYING RAIL LENGTH AND TYPE

- A. Rails shall be marked to identify the length and grade with colored paint or other identifying markings. Individual rails shall be paint-marked only one color according to grade or length. High-strength rails shall be marked by either a metal plate permanently attached to the neutral axis, hot stamped in the web, or rolled in the brand. The marking shall give the manufacturer, type, and method of treatment.
- B. Heat treated rail shall be paint-marked orange. Alloy rail shall be paint-marked aluminum color. Short rails (less than 80) feet) shall be paint-marked green. Rails meeting the tolerances for Special Trackwork shall be paint-marked white. The length of each rail shall be painted at the end of the rails in accordance with the standard practices of the manufacturer.
- C. Rails not meeting the requirements of this specification but acceptable under another specification for use in low speed industry tracks shall be paint-marked yellow. Industrial quality rails shall also be permanently identified by cutting diagonally through every "RE" or other designation within the rolled branding of the rail. Each designation brand shall be ground or milled diagonally from the top right-hand corner to the bottom left-hand corner, a minimum of 1/4" in width and to within 0.010" of the parent rail web surface.
- D. Rail Branding: Branding shall be rolled in raised characters on the side of the web of each rail at a minimum of every 16 feet. The design of the letters and numerals shall be determined by the manufacturer. The data and order of arrangement of the branding shall be as shown in the following typical brand:

136	RE	Manufacturer	2003	III or 3
(Weight)	(Section)	(Mill Brand)	(Year Rolled)	(Month Rolled)

The method of Hydrogen Elimination shall be located in the brand when a Hydrogen Elimination method other than Vacuum Treated (VT) is used.

- E. Rail Stamping:
- The web of each rail shall be hot stamped a minimum of 3 times per rail (short rails must contain a minimum of one full stamp) on the side opposite the brand, except that stamping shall not occur within 2 feet of either end of rails.
  - Rails from continuous cast blooms shall be identified by a designation for heat number, strand number, and bloom number. The rail shall be identified by an alphabetical designation beginning with "P", and succeeding "S", "T", "U", etc., consecutively, or any other identification of the position of the rail within the cast, as agreed between the purchaser and manufacturer.

3. The data shall be shown in the following typical stamping, except that strand and bloom numbers may be joined or may be coded at the manufacturer’s option. The height of the letters and numerals shall be 5/8 inch.

**Table 4 – Example Stamping Markings**

Stamping Markings					
	SS, HH, LA, IH or LH	297165	PSTU	12	BC
<b>Description</b>	<b>Rail Type</b>	Heat Number	Rail Letter	Strand and Bloom Number	Method of Hydrogen Elimination, if indicated in stamping
	SS = Standard Strength				
	HH = Head Hardened				
	LA = Low Alloy Standard Strength				
	IH = Low Alloy Intermediate				
	LH = Low Alloy Head Hardened				

4. The 5/8 inch stamped characters shall have a flat or radius face (0.040 inch to 0.060 inch wide) with bevels on each side so as not to produce metallurgical stress risers. The letters and numbers shall be rotated to a 10 degree angle from vertical and shall have rounded corners. No sharp corners are permitted. The stamping shall be between 0.020 inch and 0.060 inch in depth along the center of the web. The design shall be as shown in **Figure 1**.



**Figure 1 – Design of Special Letters and Numbers for Rail Stamps**

**2.08 RAIL MANUFACTURE TESTING**

- A. Chemistry Testing:

1. Steel from each heat must be tested to ensure that the chemistry of the finished rail conforms to the limits shown in Table 1, or the limits for any permitted alternative chemistry rail steel. Separate analyses shall be made from test samples representing the front, middle (optional), and back of the heat taken during pouring of the heat. Determination of the chemical composition may be made chemically or spectrographically. Any portion of the heat meeting the chemical analysis requirements of Table 1 (below) may be applied.
  2. Upon request by the purchaser, samples shall be furnished to verify the analysis. The analysis, most representative of the heat (clear of the transition zone for continuous cast steel), shall be recorded as the official heat analysis, but the purchaser shall have access to all chemical analysis determinations.
  3. Rail heats shall be tested for hydrogen content using a sampling/analytical method or a direct measurement method. The testing shall be performed during the continuous casting process. Hydrogen content shall be recorded and available for review or reporting at the request of the purchaser. The producer shall define the method used to determine hydrogen content, which of the following methods are used for hydrogen removal, and present evidence of applicable procedures used to control the final rail hydrogen.
    - a. Vacuum Degassing.
    - b. Bloom Controlled Cooling.
    - c. Rail Controlled Cooling.
  4. Product analysis limits may be applied only in testing for chemical composition after the rail manufacturing process is completed and will not supersede chemical composition limits done for the same heats when the steel is in the molten state.
- B. Tensile Strength Testing:
1. One longitudinal tension test specimen shall be taken from the gage corner of the rail head, centered  $\frac{1}{2}$  inch from the gage side and  $\frac{1}{2}$  inch from the running surface. The specimen shall be 0.5 inch diameter and shall be tested per ASTM A370, "Standard Test Methods and Definitions for Mechanical Testing of Steel Products."

2. If any test specimen fails because of a malfunction of the test equipment or a flaw in the specimen, it shall be discarded and another one taken. If a test specimen fails to meet the required tensile properties, two additional test specimens shall be cut from rails from the same lot and tested. If both meet the requirements, the lot shall be accepted. If one of the tests fails to meet the requirements, two additional rails from the lot shall be sampled and tested. Both of the tests must be satisfactory for the lot to be accepted. If one of these tests is unsatisfactory, each individual rail may be sampled and tested for acceptance. If the results for off-line head hardened rail fail to meet the requirements, the rails represented by the test may be re-treated and re-tested.
3. Except for high-strength rail, the test frequency shall be one test for each heat for the first one hundred heats, one test for every fifth heat for the second hundred heats and one test for every tenth heat thereafter for heats furnished to the same manufacturing practice. In addition, a minimum of one tensile test per order shall be furnished at the request of SCRRA, from a heat supplied on the order. For high-strength rail of all steel grades, the testing frequency shall be one test for each heat or 10,000 feet of rail, whichever represents the smaller amount of rail.

C. Ultrasonic Testing:

1. Rails shall be ultrasonically tested for internal imperfections. The full length of the rail shall be tested using in line ultrasonic testing equipment at the rolling mill. The rail shall be free from rough surfaces, loose scale or foreign matter which would interfere with the ultrasonic detection of defects. Testing shall be done when the rail temperature is below 150 degrees F.
2. The calibration test rail shall be a full section rail of the same section as that being tested. The test rail shall be long enough to allow a calibration at the same rate of speed as the production rail. The size, shape, location and orientation of calibration references to be placed in the test rail shall be agreed upon by the purchaser and manufacturer. At least one reference shall be put into the test rail to represent each search unit in the system.
3. The in-line testing system sensitivity level, using the calibration rail, shall be adjusted to detect a minimum 1/16 inch diameter defect anywhere in the sound path in the head, a minimum of 3/32 inch diameter in the web, and longitudinal imperfections exceeding 1/2 inch length and greater than 1/16 inch depth occurring in the base. Any indication equal to or greater than the above defect sizes when scanning the rail at the production speed shall be cause for initial rejection. A record shall be made of each suspect rail. This record shall be made available to SCRRA upon request.



4. The calibration rail shall be run through the ultrasonic testing equipment at the start of each shift or at least once each 8 hour operating turn and additionally at any section change or at any indication of equipment malfunction. A record shall be maintained by the manufacturer of each time the calibration test rail is run through the test system. This record shall be made available to SCRRA upon request. In the event of a calibration failure, all rails processed since the last successful calibration shall be retested.
5. Rejected rails may be cut back to sound metal as indicated by the ultrasonic testing. Rails shall be cut to one of the specified non-standard short lengths. The cut shall be a minimum of 12 inches from any indication.

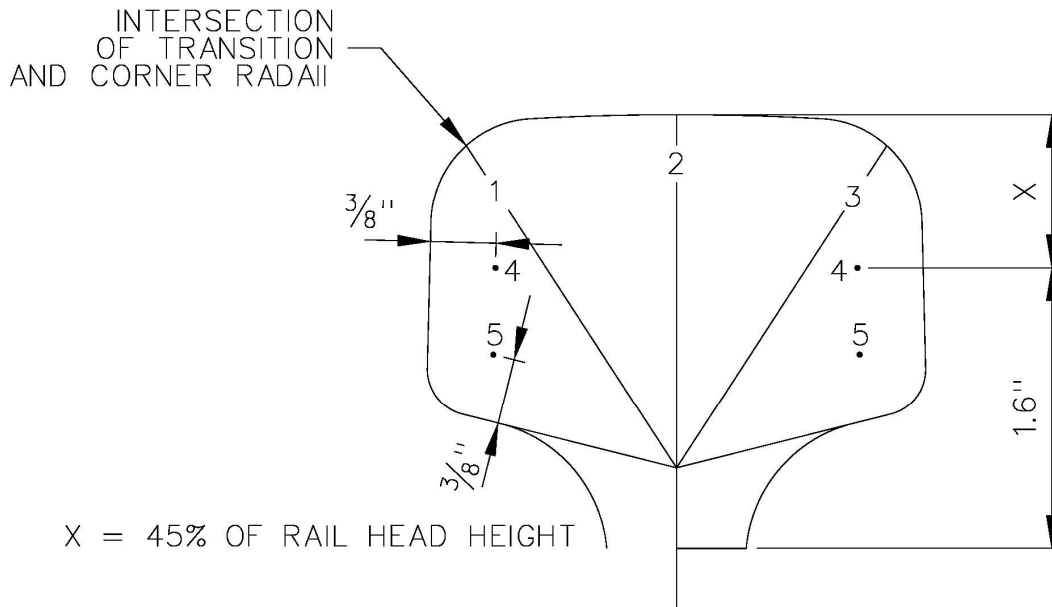
D. Brinell Hardness:

1. The Brinell hardness test shall be performed, using a tungsten carbide indenter, on a piece of rail not less than 6 inches long. The test piece shall be cut from a rail taken from each heat of steel or heat-treatment lot, or from a ground/milled transverse sample cut from the 6 inch sample rail. A copy of the report of each test shall be furnished to SCRRA.
2. The test shall be conducted in accordance with the current version ASTM E 10, "Standard Test Method for Brinell Hardness of Metallic Materials." The test shall be made on the side or top of the rail head after decarburized material has been removed to permit an accurate determination of hardness. Alternately, the test may be made on the prepared transverse ground/milled sample no less than 3/8 inch inward from all rail surfaces.
3. If any test result fails to meet the specifications, two additional checks shall be made on the same piece. If both checks meet the specified hardness, the heat or heat treatment lot meets the hardness requirement. If either of the additional checks fails, two additional rails in the heat or lot shall be checked. Both of these checks must be satisfactory for the heat or lot to be accepted. If any one of these two checks fails, individual rails may be tested for acceptance.
4. If the results for off-line head hardened rails fail to meet the requirements shown in **Table 5** (below), the rails may be retreated at the option of the manufacturer, and the retreated rails shall be re-tested.

E. Internal Hardness of High-Strength Rail:

1. The internal hardness of high-strength rail of any rail steel grade shall be determined on a transverse specimen cut from the head and at least 6 inches from the end of the rail. The specimen shall be ground or milled so that the transverse surfaces are parallel. The hardness test shall be conducted in accordance with ASTM E-18, "Standard Test Methods for Rockwell Hardness of Metallic Materials." The results shall be reported in Brinell using the conversions in **Table 5**.

2. The hardness shall be determined at intervals of not greater than 1/8 inch along traverses 1, 2, and 3 and at positions 4 and 5 as shown in **Figure 2**. Hardness gradient of head hardened rail along lines 1, 2, and 3 shall be gradual towards the center of the rail, with no sharp drop or discontinuity. Traverse 2 can extend into the web of the rail ( $X + 1.6$  inch).



	115#	119#	132#	133#	136#	140#	141#
X	3/4" 0.750"	27/32" 0.844"	25/32" 0.781"	7/8" 0.875"	7/8" 0.875"	15/16" 0.938"	1" 1.000"

**Figure 2 – Determining Internal Hardness of High Strength Rail**

**Table 5 – AREMA HRC TO HB Conversion for Rail Steels (Developed by AREMA Committee 4 specifically for rail steel)**

HRC	HB	HRC	HB	HRC	HB
20	244	30	306	41.8	400
21	250	31	314	42	402
22	255	32	321	43	411
23	261	33	328	44	420
24	267	34	336	45	429
25	273	35	344	46	439
26	280	36	351	47	448
27	286	37	359	48	458
28	293	38	368	49	468
29	300	39	376	50	478
		40	384		
$HB = 165.77 + 2.3597HRC + 0.0777HRC^2$					

3. The hardness at a depth of 0.6 inch on lines 1, 2 and 3 and at points 4 and 5 of (depth of 3/8 inch) Figure 2 shall be 352 HB or higher for high strength rail. For the low alloy head hardened rail steel grade (LH) the hardness at a depth of 7/8 inch on lines 1, 2, and 3 shall be 341 HB or higher. The testing frequency shall be one test per heat or 10,000 feet of rail, whichever is the smaller amount of rail.
  4. If any test specimen fails to meet the required hardness, two additional test specimens shall be obtained from the same lot and tested. If both meet the requirements, the lot shall be accepted. If one of the specimens fails to meet the requirements, two additional rails from the lot shall be sampled and tested. Both of these tests must be satisfactory for the lot to be accepted. If one of the tests is unsatisfactory, individual rails may be sampled and tested for acceptance. If the results for off-line head hardened rail fail to meet the requirements for internal hard, the rails represented by the test may be re-treated and re-tested.
- F. Interior Condition and Macroetch Standard Tests:
1. Sample Location and Frequency
    - a. A test piece representing a rail from each strand from the beginning of each sequence and whenever a new ladle is begun shall be shall be macroetched which is the point representative of the lowest level in the tundish (i.e. the point of the lowest ferrostatic pressure.) One additional sample from the end of each strand of the last heat in the sequence shall also be tested. A new tundish is considered to be the beginning of a new sequence.
    - b. SCRRRA may, upon receipt, examine and test any rail from any part of a heat at its option, and if the determines that the rail sample selected in rejectable, the entire heat shall be reevaluated according to Section 2.06, Part F, Paragraph D, below.
  2. Sample Preparation
    - a. A full transverse section of the rail can be cut by abrasive or mechanical means as long as care is maintained in preventing metallurgical damage. The face to be etched shall have at least a 125 microinch finish. The sample shall be degreased and totally immersed in a hot (160 degrees to 180 degrees F) one to one mixture, by volume, of concentrated hydrochloric acid (38 volume percent) and water to sufficiently etch the specimen.
    - b. Etching time shall be between ten and twenty minutes. The solution surface shall be at least one inch above the etched surface. Upon removal from the bath, the sample shall be rinsed and brushed under hot water and dried. The sample shall not be blotted dry. A rust inhibitor may be applied to the etched face at the option of the manufacturer.

### 3. Macroetch Evaluation and Rejectable Conditions

The areas of cross section shall be defined as head, web, and base in accordance with Figure 4-2-9 of Chapter 4 of the AREMA Manual for Railway Engineering. A description of each of the rejectable conditions and corresponding figure in Chapter 4 of the AREMA Manual for Railway Engineering are given in **Table 6**.

**Table 6 –Macroetch Evaluations and Rejectable Conditions**

AREMA Figure Number	Rejectable Condition
4-2-9	Definition of rail cross sectional areas for macroetch evaluation
4-2-10 and 4-2-11	Hydrogen flakes
4-2-12 and 4-2-13	Pipe; any size.
4-2-14 and 4-2-15	Central web streaking extending into the head or base
4-2-16 and 4-2-17	Streaking greater than 2-1/2 inches in length
4-2-18	Scattered central web streaking from the web into the head and base.
4-2-19	Scattered segregation extending more than one inch into the head or base.
4-2-20	Subsurface porosity
4-2-21	Inverse or negative segregation having a width greater than 3 inches and extending more than 1/2 inches into the head or base
4-2-22	Streaking greater than 1/8 inches in the head from radial streaks, radial cracks, halfway cracks, or hinged cracks
4-2-23	Other defects that could cause premature failure (i.e. slag, refractory, etc.)
4-2-24 and 4-2-25	Segregation extending into the head or base
4-2-26	Segregation greater than 1/8 inches wide in the head or base.
4-2-27	Scattered central web segregation extending into the head and base.

### 4. Retesting

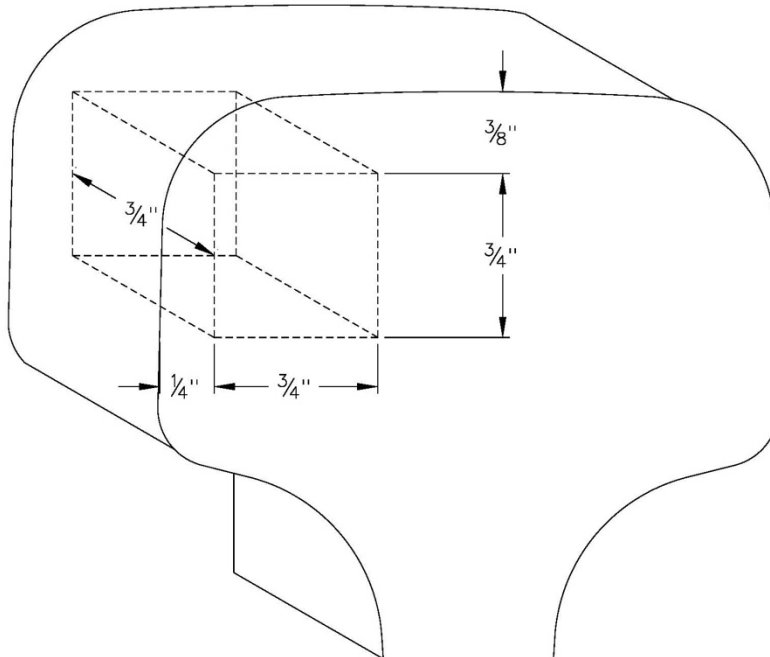
- a. If any specimen fails to meet the macroetch standard for interior quality, two additional samples of rail representative of the same strand shall be obtained. These retests shall be taken from positions selected by the manufacturer and the material from between the two retest positions shall be rejected. If any retest fails, testing shall continue until acceptable internal quality is exhibited.
- b. All rails represented by failed tests shall be rejected. If finished rail from the beginning of a strand shows defects, successive rails from that strand shall be tested until sound metal is identified. Those portions of rails exhibiting sound metal may be cut from longer rails and accepted as short rail, subject to the limitations of length.

- c. In the event that there is a question of the seriousness of the indication, further examination may be performed with a stereo microscope up to 5X. A polished sample may be inspected at 100X for metallographic interpretation.

G. Interior Condition and Microcleanliness Standard Tests:

1. Sampling

- a. The metallurgical cleanliness of the rail steel shall be determined from samples taken from the finished rail section. A minimum of every tenth heat must be tested. A minimum of three one-inch long full section samples per heat tested shall be taken, one from the end of the first acceptable rail, one from the end of a rail representing the approximate middle of the heat, and one from the end of the last acceptable rail. Test specimens will be sectioned and surface analyzed as shown in **Figure 3**.
- b. Each  $\frac{3}{4}$ " by  $\frac{3}{4}$ " section (Sample A in **Figure 3**) shall be carefully prepared and evaluated according to Method A of ASTM Standard E45, "Standard Test Methods for Determining the Inclusion Content of Steel." Each individual metallographic sample shall have a maximum average rating of 2 and a maximum individual rating of 3 for inclusions type, thin or heavy. Results shall be furnished to SCRRA purchaser upon request.



**Figure 3 – Sample “A” location in rail head – Shaded area denotes area to be analyzed**

H. Tolerances:

## 1. Section and Length

Rail shall be rolled to the standard section shown on the drawings or listed in the Schedule of Quantities and Prices within the section tolerances given in **Table 5**, and to the specified length within the tolerances given in **Table 4**. Gauges for checking basic rail dimensions shall conform to those illustrated in **Figure 4-2-28** through and including **Figure 4-2-40** of **Chapter 4 of the AREMA Manual for Railway Engineering**.

**Table 4 – Tolerance in Length**

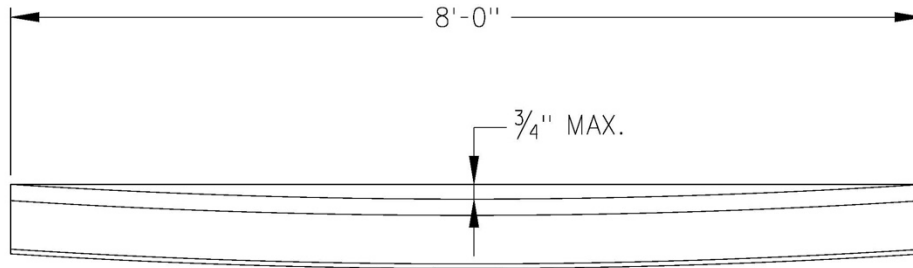
End Condition	Length > 40 ft.	Length ≤ 40 ft.
Undrilled	-0, +6 inch	-0, +4 inch
Drilled one end	-0, +6 inch	-0, +4 inch
Drilled both ends	±7/8 inch	±7/16 inch

**Table 5 – Section Tolerances**

Description	Tolerance, Inches			
	Rail		Trackwork Rail	
	Plus	Minus	Plus	Minus
Height of rail (measured within one foot from end)	0.030	0.015	0.030	0.015
Width of rail head (measured within one foot from end)	0.025	0.025	0.015	0.015
Thickness of web	0.040	0.020	0.040	0.020
Fishing template standout	0.060	0.000	0.030	0.000
Asymmetry of head with respect to base	0.050	0.050	0.030	0.030
Width of base	0.040	0.040	0.030	0.030
Flange height	0.025	0.015	0.015	0.015
Note 1: Base concavity shall not exceed 0.010 inch. Convexity is not permitted.				
Note 2: No variation will be allowed in dimensions affecting the fit of the joint bars, except that the fishing template may stand out not to exceed 0.060 inch laterally.				
Note 3: All four corners of the rail base shall have the radii according to the drawing ± 1/32 inch. Any disputes shall be analyzed on an Optical Comparator.				
Note 4: The section of the rails to be used in AREMA trackwork shall conform to the design specified by the purchaser subject to the tolerances listed under trackwork rail above.				
Note 5: Head radius to be within (±) 2 inches per Figure 4-2-40.				
Note 6: On up to 5% of the order, the height of the rail plus tolerance can be between 0.030 and 0.040 inches. This exception does not apply to trackwork rail.				

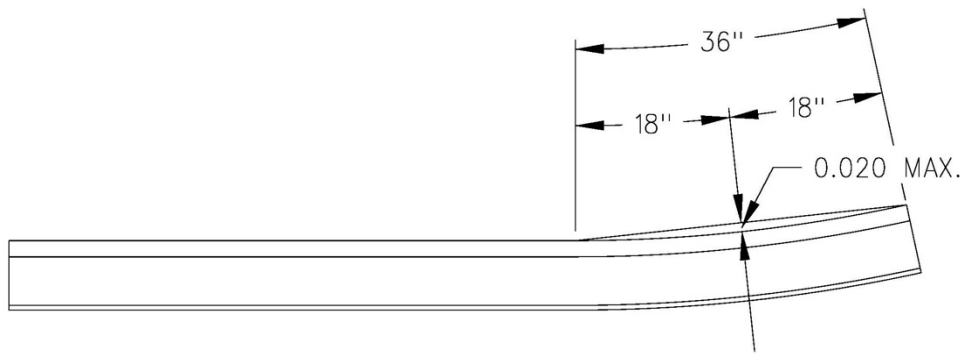
## 2. Rail Straightness

- a. When placed head up on a horizontal support, rails that have ends higher than the middle will be accepted, if they have a uniform upsweep, the maximum ordinate of which does not exceed  $\frac{3}{4}$  inch in any 80 feet as illustrated in **Figure 4**.



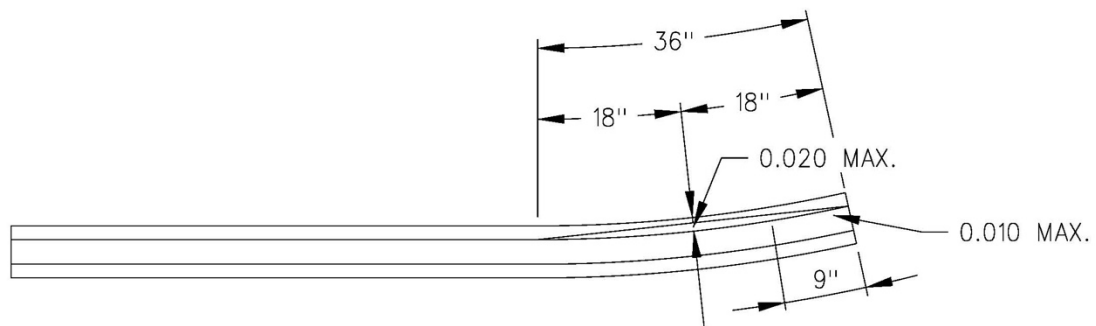
**Figure 4 – Side Elevation of Rail Uniform Upsweep Tolerance**

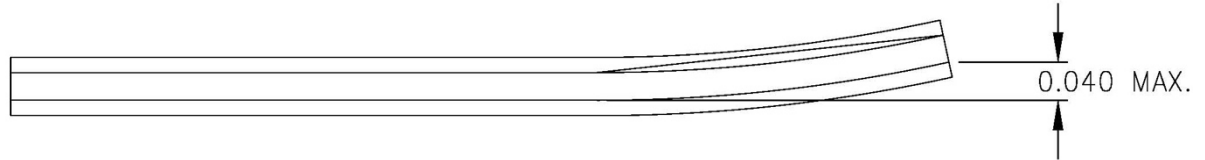
- a. The uniform surface upsweep at the rail ends shall not exceed a maximum ordinate of 0.020 inch in 3 feet and the 0.020 inch maximum ordinate shall not occur at a point closer than 18 inches from the rail end as illustrated in Figure 5. Surface down-sweep and droop must not be accepted.



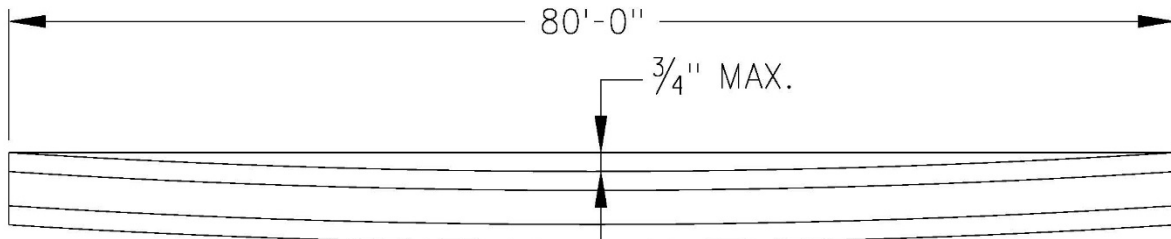
**Figure 5 – Side Elevation of Rail Uniform Upsweep Tolerance at Rail Ends**

- b. Deviations of the lateral (horizontal) line in either direction at the rail ends shall not exceed: 1) a maximum mid-ordinate of 0.020 inch in 3 feet using a straight edge and of 0.010 inch at the end quarter point as illustrated in Figure 6a.; 2) a maximum of 0.040 inch measured by the tangent offset method at the end of the rail as illustrated in Figure 6b.



**Figure 6a – Top View of Rail Lateral (Horizontal) Line Tolerance at Rail Ends****Figure 6b – Top View of Rail Lateral (Horizontal) Line Tolerance at Rail Ends**

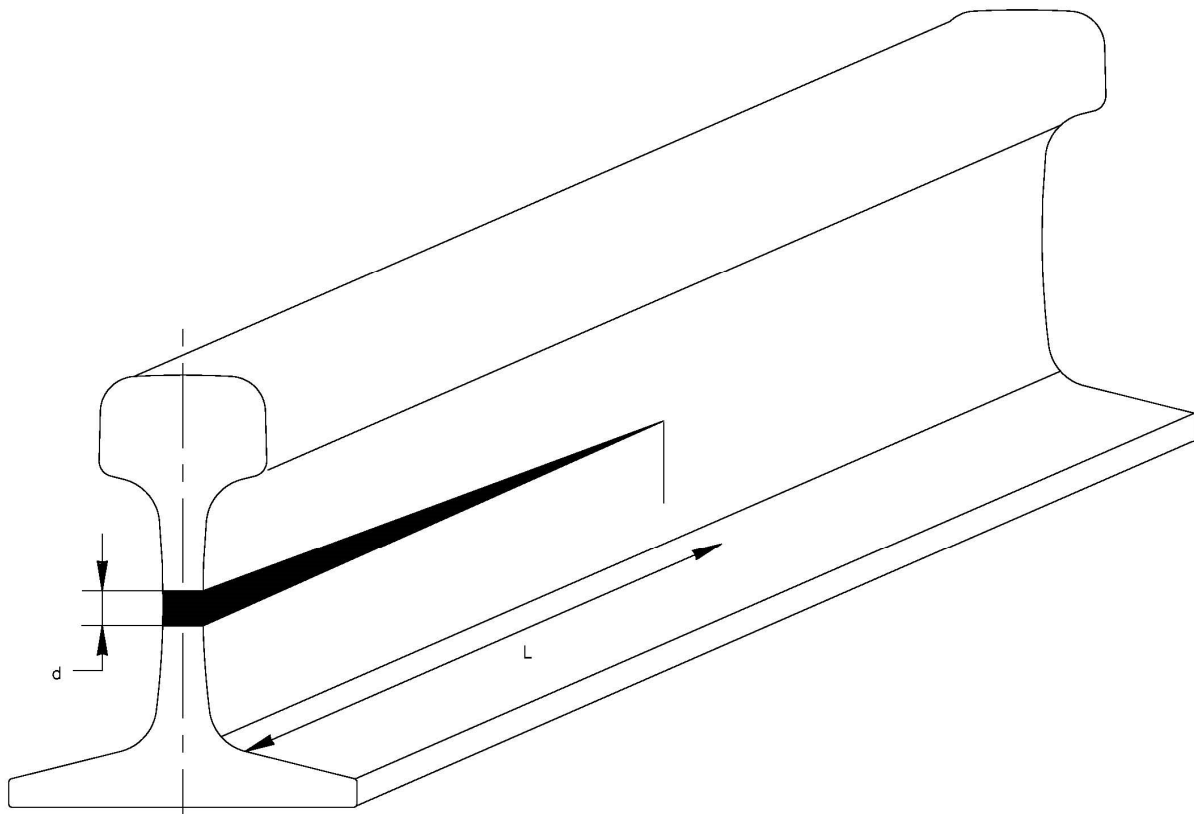
- c. Uniform lateral sidesweep in any 80 feet shall not exceed  $\frac{3}{4}$  inch as illustrated in Figure 7. When required, proof of compliance with, “Side Uniform Upsweep” tolerance shall be determined by string (wire) lining, and a straight edge and taper gage shall be used to determine rail end surface and line characteristics specified in “Uniform Surface Upsweep” tolerance and “Rail Lateral Line” tolerance. Surface downsweep and droop shall not be accepted.

**Figure 7 – Top View of Uniform Lateral Sidesweep Tolerance**

- d. Rails shall be hot sawed, cold sawed, milled abrasive wheel cut, or ground to length. Rail ends shall be square with a variation of not more than  $\frac{1}{32}$  inch allowed. The method of finishing the ends of rails shall not cause metallurgical or mechanical damage to the rail.
- e. If the rail shows evidence of twist while being laid head up on the final inspection bed, it will be checked by inserting a taper or feeler gage between the base and the rail skid nearest the end. If the gap exceeds 0.060 inch the rail will be rejected. Alternatively, a twist gage may be used and if the rail exceeds 1.5 degrees in 80 feet the rail will be rejected. Rejected rails may be subject to straightening.
- I. Evaluation of Residual Stresses in Rail by Web Saw Cut:
1. Preparation and Test
    - a. Finished rail shall meet the requirements of a web saw cut test conducted of a fully roller-straightened rail sample of a regular production rail. The rail ends not affected by the roller straightening process shall not be used for the test. For those production rails that are not roller-straightened, the rail shall also meet the following requirements of a web saw cut test.



- b. The test sample shall be 24" in length and cut from a production rail. The sample end face furthest from the end of the rail from which the sample is cut shall be punch marked with two central, vertically aligned sharp cone pointed marks, one on each side of the neutral axis a sufficient distance apart such that the marks are not affected or obliterated by the subsequent saw cut. The caliper measurement shall be taken at a distance no more than 0.25" (6mm) from the rail end at the vertical centerline of the rail. The caliper point locations shall be marked and this measurement shall be recorded.
- c. The initial vertical distance between the two punch marks shall be measured with a calibrated vernier or digital caliper and recorded. Alternatively, a calibrated vernier or digital caliper may be used to measure the initial height of the de-burred end of the rail to be saw-cut.



**Figure 8 – Rail-Web Saw Cut Test**

- d. The web of the test sample shall then be saw cut on a straight line along the neutral axis of the web for a distance (L) of 16". If the rail closes during the saw cut, sufficient material shall be removed from the mouth of the saw cut to prevent the top portion of the rail from touching the bottom portion of the rail. The sawing process shall employ a procedure and sufficient precautions such that there is no induced distortion or heating of the rail.

- e. Immediately after cutting, the distance between the two vertical punch marks shall again be measured with the vernier caliper and recorded. For the alternate method the rail height shall be re-measured by placing the caliper points at the same position on the top and base of the rail as initially measured. This value shall be recorded.
- f. For either procedure, the value after subtracting the final measurement from the initial measurement is called the vertical displacement (d). The vertical displacement may be a positive or negative value depending upon whether the longitudinal and vertical residual tensile stresses of the rail sample are in tension (+) or compression (-). The web saw cut test shall be the primary method used to evaluate the magnitude of the residual stresses in rail.

## 2. Rail Acceptance Criteria

Any rail demonstrating a vertical displacement (+ or -) of greater than 0.148" (3.75 mm) shall be rejected. For fully-hardened rails, that have significantly higher fracture toughness properties in the web of the rail, an alternate acceptance criteria based on stress intensity and fracture toughness measurements may be used if it is the standard practice of the mill to use such a test. If the stress intensity level is less than the fracture toughness level the rail may be considered acceptable.

## 3. Re-Test and Acceptance Criteria

Any rail that does not meet the acceptance criteria of the primary saw cut test, may be accepted if a steel wedge forced into the mouth of the saw cut generates crack propagation and completed fracture through either the base or head of the rail.

Alternately, any rail that does not meet the acceptance criteria in may be accepted if two additional rails from the same week's production are secured, saw cut tested and pass the primary acceptance criteria.

## 4. Testing Frequency

A rail manufacturer that has developed a continuous statistical control process and monitoring tests for control of their critical processing steps during production of rail may test a rail not less than a frequency of once each week. If a changes occur in the critical rail manufacturing processes in the course of production, tests must be taken at a frequency of one rail per 24 hours for a one week period of that change.

These monitoring tests shall demonstrate to SCRRA that there exists a positive correlation between the continuous process monitoring and the saw cut test measurements performed on the finished rail. During development of a statistical control and monitoring process, a saw cut test shall be taken at a frequency of one rail per 24 hours for a two week period.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Flash butt welding and testing of rail shall conform to the current AREMA Manual, Chapter 4, Part 2, Section, "Specification for Fabrication of Continuous Welded Rail" unless otherwise specified herein.
- B. Vendor must fabricate CWR off site.
- C. Lengths of CWR strings delivered to site shall be not less than 1,200 feet unless otherwise approved by SCRRA.
- D. Fabrication shall be in accordance with this specification.
- E. Rejected welds shall be cut out and rewelded with a minimum of 19'-6" plugs at Vendor's expense.
- F. Bolt holes for the end of CWR strings are acceptable and must be approved (size, location and number) with the SCRRA prior to shipment.

### **3.02 EQUIPMENT**

- A. The welding machine shall be capable of automatically recording pertinent data including pre-heating impulses, flashing time, upset current, time and platen travel during flashing and shall be capable of testing the welds during production using the ultrasonic testing method or the dry powder method of magnetic particle inspection.
- B. The Vendor shall maintain welding equipment in good working order at all times.

### **3.03 RAIL BENDING AND STRAIGHTENING**

- A. Straightened rail sections shall achieve the alignment tolerance as specified in AREMA Manual, Chapter 4.
- B. Any rail sections that cannot be straightened shall be cut back a sufficient distance to achieve the specified tolerances.
- C. If straightened rail does not meet specification tolerance in two passes through the straightener, it will be cut out of the string.

### **3.04 RAIL CUTTING AND END PREPARATION**

- A. Rails used for electric-flash butt welds shall have their ends saw-cut or abrasive disc-cut clean and square by means of accepted equipment.
- B. Torch cutting of rail is prohibited.
- C. The head and base of the rail for a length of approximately six inches from welding end shall have mill scale removed down to bright metal.

- D. All burrs shall be removed from the area where the welding current carrying electrodes contact on the head and base of the rail.
- E. Holes will not be permitted in the rail, except as approved by SCRRA.

### **3.05 ELECTRIC FLASH BUTT WELDING**

- A. CWR strings shall be fabricated so that all of the branding appears on one side of the string.
- B. Alignment of rail in the welding machine shall:
  - 1. Be done on the head of the rail.
  - 2. Vertical alignment shall provide for a flat running surface. Any difference in height of the rails shall be in the base.
- C. Horizontal alignment shall be done in such a manner that any difference in the widths of heads of rails shall be divided equally on both sides of the head.
- D. All electric flash butt welds shall be forged to point of refusal to further plastic deformation and have a minimum upset of 0.5 inches with 0.625 inches as standard.
- E. The upset cylinder shall not bottom out during the upset portion of the weld cycle.
- F. Post weld straightening may be permitted if performed before the surface temperature of the weld falls below 500 degrees Fahrenheit.
- G. Quenching the weld metal shall not be permitted on standard rail. Quenching of premium rail weld is permitted and shall be per the standard industry practice as accepted by class I railroad.

### **3.06 FINISHING AND ALIGNMENT**

- A. Jagged, notched or badly mismatched end faces shall be pre-flashed to an even or mated condition before setting up rails for preheating and final flashing to assure that the entire surfaces of rail ends are uniformly flashing immediately preceding upsetting.
- B. All heavy grinding used in the finishing process shall be performed on the hot metal immediately following welding, to prevent metallurgical damage.
- C. Finishing shall eliminate cracks visible to the unaided eye. Notches created by offset conditions shall be eliminated by grinding to blend variations.
- D. All notches created by offset conditions or twisted rails shall be eliminated by grinding to blend the variations.
- E. All fins on the weld due to grinding drag shall be removed prior to final inspection.

**3.07 TOLERANCES IN ELECTRIC FLASH BUTT WELDS**

- A. Trimming and grinding of rail welds shall result in the weld being within the tolerances set forth in the AREMA Manual, Chapter 4, Part 2, Section "Specifications for Fabrication of Continuous Welded Rail."

**3.08 RECORDS FOR ELECTRIC FLASH BUTT WELDING**

- A. On a bi-weekly basis a record shall be submitted to SCRRA documenting the production of each string of CWR. Included shall be the following:
  - 1. The CWR string designation number and station location in the field.
  - 2. The heat numbers of the first and last pieces of rail in the string.
  - 3. The heat numbers on each side of any weld which has been cut out and rewelded.
  - 4. A small sketch or graph indicating the current flow during the production of each weld.

**3.09 CWR STRING MARKINGS**

- A. Mark each completed string with the appropriate CWR string designation indicated in the schedule of CWR strings.

**3.10 CWR STRING HANDLING**

- A. Handling of CWR shall be in accordance with submitted procedures for transport and handling.
- B. As welding is completed on each CWR string, the string shall be transported from the welding line by the Vendor to the track location or a suitable stockpile location.
- C. The stockpile location shall be approved by SCRRA if it lies within the right-of-way.

**3.11 VISUAL INSPECTION**

- A. Production welds shall be visually inspected for surface cracks.
- B. Welds with surface cracks visible to the eye will not be accepted.

**3.12 REPLACEMENT OF DEFECTIVE WELDS**

- A. Flash butt production welds giving fault indication in magnetic particle inspection during production shall be cut, rewelded and retested and shall not be left for field welding.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

### **4.02 PAYMENT**

- A. 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 34 11 10**

**SECTION 34 11 15**  
**OTHER TRACK MATERIALS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section specifies the material requirements and performance criteria for Other Track Materials (OTM) to be furnished in accordance with Contract Documents or required by the Engineer.
- B. OTM materials shall include rail fastening systems, screw spikes, track bolts, nuts, spring washers, tie plates, tie plugs, rail anchors, standard toeless joint bars, compromise joint bars, and insulated joints.

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering
  - 2. Portfolio of Trackwork Plans
  - 3. Specifications for Special Trackwork
- B. American Welding Society (AWS):
  - 1. AWS B2.1: Standards for Welding Procedures and Performance Qualifications
  - 2. AWS D1.1: Structural Welding Code
- C. American National Standards Institute, Inc. (ANSI)
  - 1. ANSI B1.1: Unified Inch Screw Threads
  - 2. ANSI B1.3M: Screw Threads Gaging System for Dimensional Acceptability
  - 3. ANSI B18.22.1: Plain Washers
- D. American Society for Testing of Materials (ASTM)
  - 1. ASTM A36: Standard Specifications for Carbon Structural Steel
  - 2. ASTM A123: Standard Specification for Zinc (Hot-Dip-Galvanized) Coating on Iron and Steel Products
  - 3. ASTM D257: Test Methods for D-C Resistance or Conductance of Insulated Materials

4. ASTM D1002: Test Methods for Apparent Shear Strength of Single-Lap-Joint Adhesive Bonded Metal Specimens by Tension Loading (Metal to Metal)
  5. ASTM F3125: Standard Specifications for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength
- E. Association of American Railroads (AAR)
1. AAR: Manual of Standards and Rec. Practices
  2. AAR Section J: Quality Assurance M-1003
  3. AAR: Assembly and Test of Insulated Track Part 16, Signal Section
  4. AAR: Signal Manual Assembly and Testing of Insulated Fittings, Part 14.5.1
- F. SCRRRA: Engineering Standards.

### 1.03 DEFINITIONS

- A. Compromise Rail – A relatively short rail, the two ends of which are different sections, corresponding with the sections of the rail to which they are to be joined
- B. The word “Vendor” used in this Specification shall mean the Contractor.
- C. Fasteners – Joint bars, bolts, clips and spikes
- D. Joint Bar – A steel member used in pairs for the purpose of joining rail ends together, and holding them accurately, evenly and firmly in position
- E. Insulated Joint – A rail joint designed to arrest the flow of electric current from rail to rail by means of insulation placed so as to separate the rail ends and other metal parts connecting them
- F. OTM – A general term referring to all miscellaneous materials other than rail and ties
- G. Tie Plug – Rectangular sections of wood for filling unused spike holes in wood ties
- H. Switch – A track structure to divert rolling stock from one track to another

### 1.04 SUBMITTALS

- A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the OTM have been placed in service.



- B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.
- C. The Vendor shall submit OTM packaging, loading, shipping, and handling method.
- D. The Vendor shall submit for SCRRA's review and approval quality control and quality assurance plans and related certifications such as ISO 9001, "six sigma" or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality OTM included in the Schedule of Quantities and Prices.
- E. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing OTM to Class 1 Freight, passenger or commuter railroads.
- F. The Vendor shall include installation instructions. The Vendor shall Include, at a minimum, the Care and storage of materials; Date of glue manufacture; Glue shelf life; Rail end preparation; Weather and temperature restrictions; Mixing and application of glue; Installation of insulated joint bar and pin bolts; Curing restrictions; Detection of glue bond failures
- G. Submit Certificates of Compliance for all OTM. Include material qualification test reports for materials, components, and assemblies.
- H. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRA's Standard Specifications Section 01 25 00, "Substitution Procedures". The specifications are available on SCRRA's website at [www.metrolinktrains.com](http://www.metrolinktrains.com).

#### **1.05 QUALITY ASSURANCE**

- A. Vendor's Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program. Comply with AREMA Portfolio of Trackwork Plans.
- B. Materials or partially or fully assembled products not meeting the specifications shall be rejected. OTM delivered to SCRRA shall be either promptly modified to meet specifications or removed from SCRRA's delivery and storage locations within 30 calendar days.
- C. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.

#### **1.06 DELIVERY, STORAGE AND HANDLING**

- A. The Vendor shall load, transport, and handle the material in a manner which will prevent damage to the material.

- B. The material will be supplied to the SCRRA in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRA representative. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.
- C. All materials delivered will be colored coded and have bar coded control tags using bar code # 128 system or as approved by SCRRA on all parts/hardware for easy assembly by field personnel.
- D. Steel tie plates shall be palletized, with each standard non-returnable pallet holding not more than 6,000 pounds. Binding for the palletized tie plates shall be of sufficient strength to facilitate multiple loading, unloading and handling with cranes and/or forklifts.
- E. Resilient fasteners shall be packaged in burlap bags or other suitable container, with the weight of each package not exceeding 125 pounds. The bag or container shall be of sufficient strength to facilitate multiple loading, unloading and handling and storage.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. OTM shall be new and conform to SCRRA Engineering Standards.
- B. OTM ordered to the Engineering Standards shall be produced in conformance to these specifications and AREMA Specifications for Special Trackwork.

### **2.02 TIE PLATES**

- A. Tie plates shall conform to AREMA Volume 1, Chapter 5, Section 1.1, Tie Plates - "Specifications for Steel Tie Plates" and appropriate SCRRA Engineering Standard.
- B. Tie plate dimensions for resilient fastening systems for 5½" base shall conform to SCRRA Engineering Standard ES2453, "Rolled Steel Tie Plate to Suit 5½" Base AREMA Rail and Pandrol Rail Clips E2055". Tie plate dimensions for resilient fastening systems shall conform to SCRRA Engineering Standard ES2454, "Rolled Steel Tie Plate to Suit 132 LB. RE – 141 LB. RE Rail and Pandrol Rail Clips E2055".
- C. Tie plate dimensions for standard fastening systems for 5½" base shall conform to SCRRA Engineering Standard ES2451, "Standard 13" Tie Plate for 5½" Base Rail". Tie plate dimensions for standard fastening systems for 6" base shall conform to SCRRA Engineering Standard ES2452, "14" Tie Plate for 6" Base Rail".

### 2.03 TRACK SPIKES

- A. Cut spikes shall be new and conform to the requirements of the AREMA Manual, Chapter 5, Part 2, Section 2.1, "Specifications for Soft-Steel Track Spikes", and SCRRA Engineering Standard ES2355.
- B. Cut spikes shall be 5/8 inches by 6 11/16 inches and conform to all other dimensions specified in the AREMA Manual, Chapter 5, Part 2, Section 2.2, "Design of Cut Track Spike".
- C. Screw spikes shall be 15/16 inch by 6 inches straight shank screw spikes with a minimum tensile strength of 73,000 psi. Head shall be hot forged and centered relative to the shank in accordance with SCRRA Engineering Standards ES2355.
- D. Screw spikes for grade crossing panels shall be "Evergrip" or equal and shall be as per ES2355.
- E. Stamp screw spikes with manufacturer's identification and date of manufacture (month and year) in accordance with SCRRA Engineering Standard ES2355.

### 2.04 RAIL ANCHORS

- A. Rail anchors shall be Channeloc-type rail anchors manufactured by Chemtron True Temper or equal.
- B. Material for rail anchors to be high carbon steel. Material to be heat treated to Rc 34-47.
- C. Rail anchors shall be sized to conform to the rail section used. Rail anchors shall have sufficient bearing area and depth to minimize the possibility of the anchor damaging or becoming embedded in the tie.
- D. Rail anchors shall conform to the AREMA Manual, Chapter 5, Part 7, Section 7.1, "Specifications for Rail Anchors". Rail Anchors shall be one-piece conforming to the requirements of AREMA Manual and of standard weight.
- E. Rail anchor applications shall be in accordance with SCRRA Engineering Standard ES2351.

### 2.05 TRACK BOLTS, NUTS AND SPRING WASHERS

- A. Track bolts and nuts shall conform to the dimensions specified in the AREMA Manual, Chapter 4, Part 3, Section 3.3, "Rail Drilling, Bar Punching, and Track Bolts". Track bolts, nuts and washers shall conform to the requirements of the AREMA Manual, Chapter 4, Part 3, Section 3.5, Specifications for Heat-Treated Carbon-Steel Track Bolts, and Carbon-Steel Nuts.
- B. Spring Washers shall conform to the requirements of the AREMA Manual, Chapter 4, Part 3, Section 3.6, Specifications for Spring Washers.

## 2.06 RESILIENT FASTENING SYSTEM

- A. Resilient fastening system for wood ties shall be a Pandrol rail fastening system per relevant SCRRA Engineering Standards, "Pandrol Rail Clip – Type "e" 2055", consisting of elastic fastener "E-Clip" galvanized, type elastic clips, screw spikes, and elastic fastener tie plates or approved equal or as otherwise indicated in the Contract Drawings. Pandrol "E-Clip" shall be galvanized as required per ES2362.
- B. Resilient fastening system for concrete ties shall be a Pandrol Rail fastening system per relevant SCRRA Engineering Standards consisting of "Fast-Clip" type elastic fasteners pre-installed in the "off" position on concrete ties, or approved equal, unless indicated otherwise on the Contract Drawings.
- C. Rail seat pads shall be "3-part" with steel interior plate.
- D. Resilient fasteners for Insulated Joints shall be type specified in SCRRA Engineering Standards for the type of resilient fasteners to be used.
  - 1. The Contractor must provide suitable fasteners in accordance Relevant Engineering Standards requirements.

## 2.07 JOINT BARS

- A. Joint bars shall conform to AREMA Volume 1, Chapter 4, Part 3, Section 3.2, "Joint Bars and Assemblies"; Section 3.3, "Rail Drillings, Bar Punchings and Bolts"; and Section 3.4, "Specifications for Quenched Carbon-Steel Joint Bars, Micro-alloyed Joint Bars and Forged Compromise Joint Bars".
- B. Bar dimension and details shall conform to SCRRA ES2502, "Rail and Joint Assembly for 136 lbs. RE Rail".
- C. Joint bars used to temporarily connect rails that will be field welded in the final configuration shall be bolted with the rails ends drilled in the outer four holes only.

## 2.08 COMPROMISE JOINT BARS

- A. Compromise Joints or connections to other rail weights on SCRRA mainline track (track used in passenger revenue service will be considered mainline track for purposes of this section) will be made through the use of transition rails as specified in SCRRA ES2372 or ES2373 as appropriate.
- B. Other rail weight connections or those connections necessary for "Industry Track" or "Other than main line" will be made using Compromise Bars.
- C. Compromise Bars shall be 6-hole conforming to AREMA Volume 1, Chapter 4, Part 3, Section 3.4, "Specifications for Quenched Carbon-Steel Joint Bars, Micro-alloyed Joint Bars and Forged Compromise Joint Bars" and conform to the requirements of SCRRA ES2503, "Compromise Joints for Various Weights of Rail".

- D. Final configuration of the track shall utilize field welds to join transition rails wherever applicable in mainline track.
- E. Compromise joint bars may be used for interim phases of construction on mainline track provided interim phase duration is expected to be six (6) months or less.
- F. Temporary Compromise joint bars as noted above shall use track bolts in the outer four holes only.

## **2.09 INSULATED RAIL JOINTS**

- A. Bonded insulated rail joints shall conform to the current requirements of the SCRRA Engineering Standards ES2504 and AREMA Manual, Chapter 4, Part 3, Section 3.8, "Specifications for Bonded Insulation Rail Joints".
- B. Insulated rail joints shall be of the epoxy-bonded type as manufactured by Allegheny Rail Products, Co., or equal.
- C. Insulated rail joints shall be complete with bars, end posts, bushing, washers, pin bolts, collars, washers and adhesives.
- D. Straight bars shall be new and smooth and will be providing full face contact, conforming to the applicable rail section, and fabricated from material which meets or exceeds the mechanical properties and workmanship requirements of the current AREMA Volume 1, Chapter 4, Part 3, Section 3.4, "Specifications for Quenched Carbon-Steel Joint Bars, Micro-alloyed Joint Bars and Forged Compromise Joint Bars". The toe of the joint bar shall properly fit against the web of the rail. When elastically fastened, the joint bar shall provide adequate clearance to maintain electrical isolation.
- E. Pin bolts shall be of ASTM A325 structural steel furnished with the appropriate collar.
- F. Flat circular shall be hardened steel washers in accordance with ASTM F436.
- G. Bolt hole size shall be in accordance with the bonded insulated joint Vendor's recommendation. If bolt hole diameter is larger than 1-3/16 inches, place ASTM A325 hardened washers between the joint bars and the nut. Refer to SCRRA ES2370 for details.
- H. The bolt hole locations shall be as specified in AREMA, Chapter 4, Part 3, Section 3.3, Rail for a 36-inch joint bar. Insulated joint bar lengths for main track installations shall be 36 inches.
- I. Insulated material shall be high pressure, laminated design, impervious to oil, grease, and water, and having electrical characteristics equal to or greater than fiber insulation meeting requirements of the AAR Manual, Part 14.5.1, and electrical resistance tested as specified.
- J. Each plug shall be Megohmmeter electrical resistance tested as per AREMA Manual.

**2.10 TIE PLUGS**

- A. Tie hole plugging material shall be SpikeFast as supplied by Willamette Valley Company of Eugene, Oregon, or equal.

**2.11 SUPERELEVATION TAGS**

- A. Furnish metal superelevation tags manufactured from 16-gauge aluminum in accordance with SCRRA Engineering Standard ES2206. Stamp tags in 1/4-inch increments from zero to maximum superelevation.
  - 1. Nails for Securing Tags to Timber Crossties: Galvanized No 10.
  - 2. Adhesive for Securing Tags to Concrete Ties must be approved by SCRRA.

**2.12 DERAILS**

- A. Derails shall be as per SCRRA Engineering Standard ES2604. The sliding and hinged derails shall be painted yellow.
- B. Crowder derail shall be as per SCRRA Engineering Standard ES2613 and ES2614.

**2.13 SOURCE QUALITY CONTROL**

- A. During OTM fabrication, perform the tests and inspections specified in the AREMA Specifications.
- B. The bonded insulated rail joints shall meet electrical resistance test as specified in AREMA Chapter 4, Section 3.8.7.3.

**PART 3 - EXECUTION****3.01 GENERAL**

- A. Comply with the SCRRA Engineering Standards Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

**3.02 SCHEDULE**

- A. The Vendor providing the materials shall contact SCRRA's Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

### **4.02 PAYMENT**

- A. 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 34 11 15**

**SECTION 34 11 23**  
**SPECIAL TRACKWORK**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section specifies the material requirements and performance criteria for the Special Trackwork to be furnished in accordance with Contract Documents or required by the Engineer.
- B. Special Trackwork materials furnished under this IFB shall include rail, switches, frogs, insulated joints, derails, compromise/transition rail, stick rail, and bumping posts and individual turnout components to be used as replacement parts. All materials furnished shall be entirely new materials.
- C. Special Trackwork materials furnished under this IFB shall be utilized in the "general railroad system of transportation" within the meaning of 49 CFR 213.1 (Track Safety Standards) and will be used in dense traffic mixed passenger/commuter and freight railroad service.

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering
  - 2. Portfolio of Trackwork Plans
  - 3. Specifications for Special Trackwork
- B. American Welding Society (AWS):
  - 1. AWS B2.1: Standards for Welding Procedures and Performance Qualifications
  - 2. AWS D1.1: Structural Welding Code
- C. American National Standards Institute, Inc. (ANSI)
  - 1. ANSI B1.1: Unified Inch Screw Threads
  - 2. ANSI B1.3M: Screw Threads Gaging System for Dimensional Acceptability
  - 3. ANSI B18.22.1: Plain Washers
- D. American Society for Testing of Materials (ASTM)
  - 1. ASTM A307: Carbon Steel Externally Threaded Standard Fasteners



2. ASTM D257: Test Methods for D-C Resistance or Conductance of Insulating Materials
  3. ASTM E325: Requirements for a Testing and Inspection Laboratory
- E. Association of American Railroads (AAR)
1. AAR: Manual of Standards and Rec. Practices
  2. AAR Section J: Quality Assurance M-1003
- F. SCRRRA: Engineering Standards.
- G. BNSF: BNSF Railway applicable specifications and standards
- H. UPRR: Union Pacific Railroad applicable specifications and standards

### 1.03 DEFINITIONS

- A. Closure Rails – The rails between the parts of any Special Trackwork layout, such as the rails between the switch and the frog in a turnout
- B. The word “Vendor” used in this Specification shall mean the Contractor.
- C. Fasteners – Joint bars, bolts, clips and spikes
- D. Frog – A track structure used at the intersection of two running rails to provide support for wheels and passageways for the flanges, thus permitting wheels on either rail to cross the other
- E. Guard Rail – A rail or other structure laid parallel with the running rails of a track – used to hold wheels in correct alignment to prevent their flanges from striking the end of switch points of frog points
- F. Point Rail – Switch rail or switch point – the tapered rail of a switch used to divert traffic along either route of a turnout
- G. Railbound Manganese Steel Frog- A frog consisting essentially of a manganese steel body casting fitted into and between rolled rails and held together with bolts, known as RBM
- H. Running Rail – The rail that carries a wheel as differentiated from a guard rail or flange rail which carry no weight
- I. Spring Frog – A frog having a movable wing rail which is normally held against the point rail by springs thus making an unbroken sunning surface for wheels using the track. The flanges of wheels on the other track force the movable wing rail away from the point rail to provide a passageway
- J. Stock Rail – A running rail against which the switch points operate
- K. Switch – A track structure to divert rolling stock from one track to another

**1.04 SUBMITTALS**

- A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the turnouts have been placed in service.
- B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.
- C. The Vendor shall submit Special Trackwork packaging, loading, shipping, and handling method.
- D. The Vendor shall submit for SCRRA's review and approval quality control and quality assurance plans and related certifications such as ISO 9001, "six sigma" or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality Special Trackwork Materials included in the list of Special Trackwork items as provided in the Schedule of Quantities and Prices.
- E. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing Special Trackwork material to Class 1 Freight, passenger or commuter railroads.
- F. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRA's Standard Specifications Section 01 25 00, "Substitution Procedures". The specifications are available on SCRRA's website at [www.metrolinktrains.com](http://www.metrolinktrains.com).

**1.05 QUALITY ASSURANCE**

- A. Vendor's Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program. Comply with AREMA Portfolio of Trackwork Plans.
- B. Materials or partially or fully assembled products not meeting the specifications shall be rejected. Special Trackwork materials delivered to SCRRA shall be either promptly modified to meet specifications or removed from SCRRA's delivery and storage locations within 30 calendar days.
- C. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.
- D. Insulated gauge plates and switch rods shall be tested in accordance with AAR Manual, Part 116, Signal Section, Assembly and Test of Insulated Track Fittings.

**1.06 DELIVERY, STORAGE AND HANDLING**

- A. The Vendor shall load, transport, and handle the material in a manner which will prevent damage to the material.

- B. Band all switch points and stock rails together in one package for each turnout unit.
- C. Package all frog as a single unit per turnout, and identify to indicate the turnout number.
- D. Band guard rails together, and identify as to which turnout it is to accompany.
- E. The material will be supplied to the SCRRA in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRA. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.
- F. All materials delivered will be colored coded and have bar coded control tags using bar code # 128 system or as approved by SCRRA on all parts/hardware for easy assembly by field personnel.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. Use SCRRA Standard Specifications and Engineering Standards for all turnouts and crossovers and related replacement and spare parts.
- B. Rails, castings, forging, rolled shapes, washers, and fastening used in Special Trackwork ordered to the Engineering Standards shall be produced in conformance to these Specifications and AREMA Specifications for Special Trackwork.

### **2.02 RAIL**

- A. All steel rail used in the manufacturing of switches, turnouts and crossovers shall be new Low Alloy, Head Hardened, High Strength Grade HH or LH 136 RE (10-inch radius) conforming to AREMA Chapter 4, Part 2, Section 2.1, "Specifications for Steel Rail" and shall meet or exceed 370 HB or new BNSF Specification HH 370 Rail or an equivalent "Premium Type Head Hardened" Rail. If the Bidder is providing rail from a BNSF or UP specification that meets or exceeds these specifications and the AREMA standard – the Special Trackwork Manufacturer shall supply a copy of the applicable UPRR or BNSF standard for the rail being furnished.

### **2.03 SWITCHES**

- A. All switch point rails and stock rails shall be Samson type construction in accordance with SCRRA Engineering Standards.

- B. Switch rails shall be fully heat-treated per specifications for heat-treated rails for Special Trackwork, Plan No. 100-92 Specifications in the AREMA Portfolio of Trackwork Plans.
- C. Switch rod assemblies shall conform to AREMA Specifications for Special Trackwork, rolled mild steel.

## 2.04 FROGS

- A. Spring frogs shall conform to SCRRRA Engineering Standards or approved equal. Castings shall be 3-shot explosion-hardened. Rail shall be deep head hardened rail. Furnish frogs without plates for turnouts and crossovers on concrete ties. Bolts shall be 1-3/8-inch Grade 8 square head with 1/4 inch hardened flat washers and hexagon security locknuts. Lubricate frog bolts and torque to 2,500-foot pounds.
- B. Railbound Manganese (RBM) frogs with elastic fastening system shall conform to SCRRRA Engineering Standards or approved equal. Manganese castings shall be 3-shot explosion-hardened in accordance with AREMA Specifications. Heel of the frog shall incorporate a 30-degree cut. Frog plates shall be with one inch round holes except as otherwise indicated on the SCRRRA Engineering Standards. Bolts shall be 1-3/8-inch Grade 8 square head with 1/4 inch hardened flat washers and hexagon security locknuts. Lubricate frog bolts and torque to 2,500-foot pounds.
- C. Heavy Point Railbound Manganese (RBM) frogs shall conform to AREMA Standards. Manganese castings shall conform to AREMA Specifications. Insert shall be explosive depth hardened to Brinell 352 per AREMA Specifications. Frogs shall be constructed to tolerances given on AREMA Plan 1021-03, Permissible Variations in Completed RBM Steel Frogs. Bolts shall be 1-3/8 inch Grade 8 square head with 1/4 inch hardened flat washers and hexagon security locknuts. All bolt holes in rail are to be chamfered 1/16 inch. Lubricate frog bolts and torque to 2,500 foot pounds.
- D. Casting for frog inserts manganese steel shall be in accordance with AREMA Specifications for Special Trackwork, Article M2.
- E. Frog guard rails may be machined initially and subsequently heat treated to achieve the requirements of high strength rail as specified n AREMA Specifications.
- F. Tie plates shall conform to AREMA Volume 1, Chapter 5, Section 1.1, Tie Plates - "Specifications for Steel Tie Plates" and appropriate SCRRRA Engineering Standard.

## 2.05 INSULATED JOINTS

- A. Bonded insulated rail joints shall conform to the current requirements of the SCRRRA Engineering Standards ES2504 and AREMA Manual, Chapter 4, Part 3, Section 3.8, "Specifications for Bonded Insulation Rail Joints".

- B. Insulated rail joints shall be of the epoxy-bonded type as manufactured by Allegheny Rail Products, Co., or equal.
- C. Insulated rail joints shall be complete with bars, end posts, bushing, washers, pin bolts, collars, washers and adhesives.
- D. Straight bars shall be new and smooth and will be providing full face contact, conforming to the applicable rail section, and fabricated from material which meets or exceeds the mechanical properties and workmanship requirements of the current AREMA Volume 1, Chapter 4, Part 3, Section 3.4, "Specifications for Quenched Carbon-Steel Joint Bars, Micro-alloyed Joint Bars and Forged Compromise Joint Bars". The toe of the joint bar shall properly fit against the web of the rail. When elastically fastened, the joint bar shall provide adequate clearance to maintain electrical isolation.
- E. Pin bolts shall be of ASTM A325 structural steel furnished with the appropriate collar.
- F. Flat circular shall be hardened steel washers in accordance with ASTM F436.
- G. Bolt hole size shall be in accordance with the bonded insulated joint Manufacturer's recommendation. If bolt hole diameter is larger than 1-3/16 inches, place ASTM A325 hardened washers between the joint bars and the nut.
- H. The bolt hole locations shall be as specified in AREMA, Chapter 4, Part 3, Section 3.3, Rail Drillings, Bar Punchings and Bolts, for a 36-inch joint bar. Insulated joint bar lengths for main track installations shall be 36 inches.
- I. Insulated material shall be high pressure, laminated design, impervious to oil, grease, and water, and having electrical characteristics equal to or greater than fiber insulation meeting requirements of the AAR Manual, Part 14.5.1, and electrical resistance tested as specified.
- J. Each plug shall be Megohmmeter electrical resistance tested as per AREMA Manual.

## **2.06 DERAILS**

- A. Bi-directional Power Sliding Derail 136RE shall be Hayes model HBXS or approved equal. Derail package shall include all rods, hardware and wood switch timbers, dual powered Electric/Hand operated machine, target and fasteners. Derail to be compatible with 136 lb. rail.
- B. Bi-directional Sliding Derail 136RE shall be Hayes model HBXS or approved equal. Derail package shall include all rods, hardware and wood switch timbers, low profile switch stand, target and fasteners. Derail shall be compatible for use with or without electric lock. Derail to be compatible with 136 lb. rail.

- C. Switch Point Derail 136RE or Double Switch Point Derail with wood switch timbers shall meet the requirements of SCRRA Engineering Standard drawing ES2601, ES2602 and ES2604. 16'-6" switch points, Pandrol plates, and galvanized e-clip fasteners with all rods, connection hardware, and target shall be included for use with Union Switch and Signal M23E USS model machine. Derail to be compatible with 136 lb. rail.
- D. Rail Mounted Flop-over Derail shall be bi-directional with flag, 136RE or 115RE as listed in the Schedule of Quantities and Prices, all hardware and mounting kit included.

## **2.07 COMPROMISE/TRANSITION RAIL**

- A. Forged transition rail shall be manufactured in accordance to SCRRA Engineer Standards: 141RE/136RE to 115RE according to ES2372, or 141RE/136RE to 132RE according to ES2373.

## **2.08 STICK RAIL**

- A. Furnish 80'-0" long rail with blank ends. All stick rail to comply with the requirements in Section 2.02 Rail.

## **2.09 BUMPING POST**

- A. Bumping Post shall be as manufactured by Western Cullen Hayes Model "WAC" Bumping Post or equal. Western Cullen Hayes "Hayco Cushion Head" or equivalent that matches with the WAC bumping Post. Bumping post to be compatible for stopping Passenger Cars.
- B. Bumping post shall be as per SCRRA Engineering Standard ES2616.

## **2.10 SWITCH STANDS**

- A. Hand throw switch stands shall be Racor 36-EH switch stand or approved equal furnished with a 14-inch red target with reflective material such as Scotchlite or equal on both sides.
- B. Hand throw switch stand for crossovers shall be Racor 36-E switch stand, or approved equal, furnished with a 40 1/2 inch straight handle providing maximum clearance between tracks and an 8-inch red target with reflective material such as Scotchlite or equal on both sides.
- C. Hand throw switch stand for double point split switch derail shall be Racor 36-EH switch stand, or approved equal, in accordance with SCRRA Engineering Standards furnished with a 14-inch round "D" target with yellow reflective material such as Scotchlite or equal on both sides.

## **2.11 CROSS TIES**

- A. Furnish wood switch ties as required for turnout complete packages. All wood ties furnished with this IFB will be pre-plated and conform to the requirement in SCRRA

spec Section 34 11 34.

- B. Furnish concrete switch ties as required for turnout complete packages. All concrete ties furnished with this IFB will conform to the requirement in SCRRA spec Section 34 11 33 and will need to conform to the dimensions as shown in the standard drawings.

## **2.12 SOURCE QUALITY CONTROL**

- A. During Special Trackwork fabrication, perform the tests and inspections specified in the AREMA Specifications.
- B. Examine each forging and weld by the dry powder method of magnetic particle inspection in accordance with ASTM E709.
- C. Perform ultrasonic testing on all forging and welds in accordance with ASTM E164.
- D. All frog points shall be Brinell hardness tested on the head and along the side wearing surface in accordance with ASTM E10.
- E. The bonded insulated rail joints shall meet electrical resistance test as specified in AREMA Chapter 4, Section 3.8.7.3.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Comply with the SCRRA Engineering Standards Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

### **3.02 SCHEDULE**

- A. The Vendor providing the materials shall contact SCRRA's Material Management Supervisor, 48 hours prior to the date of delivery.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Special Trackwork will be measured by the unit or fraction thereof supplied in accordance with the IFB. The quantities as contained on the Schedule of Quantities and Prices will be used as the basis for this measurement.

**4.02 PAYMENT**

- A. Special Trackwork supplied in accordance with the IFB will be paid for at the contract unit price as listed in the Schedule of Quantities. This price shall be full compensation for furnishing labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for Special Trackwork described by the Contracts Documents.

**END OF SECTION 34 11 23**



## SECTION 34 11 26

### BALLAST

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. This Section specifies the material requirements and performance criteria for ballast to be furnished in accordance with Contract Documents or required by the Engineer.
- B. Ballast shall consist of crushed stone which is angular fragments resulting from crushing by mechanical means the following types of rocks quarried from undisturbed, consolidated deposits: granite and similar phanero-crystalline igneous rocks, extrusive igneous rocks, or massive metamorphic quartzite or similar rocks. No crushed gravel shall be allowed.

##### 1.02 REFERENCES

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering
  - 2. Portfolio of Trackwork Plans
  - 3. Specifications for Special Trackwork
- B. ASTM International (ASTM):
  - 1. C88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
  - 2. C117: Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing.
  - 3. C127: Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
  - 4. C131: Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - 5. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 6. C142: Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
  - 7. C535: Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

8. D4791: Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
  9. D3744: Standard Test Method for Aggregate Durability Index.
  10. D3042: Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  11. E11: Standard Specification for Wire Cloth and Sieves for Testing Purposes.
- C. CALTRANS: Standard Specifications – State of California Department of Transportation – Current Edition
1. SCRRA: Engineering Standards, and Metrolink Track Maintenance Manual, particularly but not limited to SCRRA ES2007-02.

### 1.03 DEFINITIONS

- A. Fine Graded Aggregates – Mineral aggregates which will pass a No. 4 mesh screen and be retained on No. 200 screen
- B. The word “Vendor” used in this Specification shall mean the Contractor.
- C. Fine Screening – Material below No. 4 mesh screen
- D. Gravel – A rock fragment whose diameter range from 2 to 64 mm
- E. Hardness of Minerals – A scale of hardness used as an aid in identifying minerals and based on a scale of one to ten with talc having a value of one and diamond a value often

### 1.04 SUBMITTALS

- A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the turnouts have been placed in service.
- B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.
- C. Representative samples of ballast, of not less than 150 pounds for gradation and other required tests shall be taken from each source of ballast and tested as specified herein. Samples will be delivered to Authority within 20 days of award. Each shipment of ballast shall be accompanied by a certification as specified.
- D. The Vendor shall submit for SCRRA’s review and approval quality control and quality assurance plans and related certifications such as ISO 9001, “six sigma” or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality ballast included in the list of ballast items as provided in the Schedule of Quantities and Prices.

- E. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing Special Trackwork material to Class 1 Freight, passenger or commuter railroads.

#### **1.05 QUALITY ASSURANCE**

- A. Testing shall be performed by Vendor's independent certified testing laboratory approved by SCRRA.
- B. The Vendor shall provide laboratory certification that ballast Material meets the Specifications of this Section.
- C. If the Vendor observes ballast material not suitable for work, or not in compliance with this part, SCRRA must be notified within three (3) hours of discovery of condition.
- D. The product delivered shall be from the same source from which samples were tested and found to conform to the Specification and shall be of the same type and quality of that which was tested.

#### **1.06 DELIVERY, STORAGE AND HANDLING**

- A. Prepared ballast shall be handled in such a manner that it is kept clean and free from segregation, and when delivered, the ballast shall be clean and free from rubbish or any substance, which might foul the ballast.
- B. Blending, stockpiling, and other production and handling operations must be managed by the Vendor to minimize segregation of finished product.
- C. Stockpiling operations shall minimize breakage or excessive fall in stockpiling operations.
- D. The movement of wheeled or tracked machines over stockpiled or installed Materials shall be limited.
- E. The material will be supplied in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRA release document. The material is to be delivered to the six-county Los Angeles area at a place designated by the SCRRA representative. The delivery must be coordinated with SCRRA representative prior to shipping and loading.
- F. In the event of an emergency, the Vendor shall use its best efforts to provide 200 tons of products within 6 hours of notice, 400 tons within 24 hours' notice, and 800 tons within 48 hours. The emergency status shall be determined by the Engineer. The Vendor is entitled to a surcharge to the unit price for emergency deliveries. If an emergency delivery occurs outside regular operating hours (The Vendor will be required to advise Authority, in writing, of operating hours or changes thereof) the Vendor will be entitled to a 10% surcharge to the unit price. Vendor must identify on each invoice which delivery is subject to the surcharge and identify the Authority representative who ordered the product under the emergency status.

- G. Vendor shall be responsible for unloading ballast under the direction of the Engineer.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. Use SCRRA Engineering Standards ES2007 for all ballast and sub-ballast supply.

### **2.02 MATERIAL GRADING REQUIREMENTS**

- A. Ballast gradation shall conform to SCRRA ES2007-02 and AREMA Volume 1, Chapter 1, Section 2.4.4, Table 1-2-2, Standard No. 4A ballast unless otherwise noted. Gradation test shall be determined in accordance to ASTM C136, utilizing square opening sieves conforming to ASTM E11.
- B. Sub-Ballast or aggregate base gradation shall conform to SCRRA ES2007-02 and the quality requirement outlined in the most current Caltrans Standard Specifications Section 26-1.02A Class 2 Aggregate Base and or aggregate base gradation shall conform to SCRRA ES2007-02 and the quality requirements outlined in the most current Caltrans Standard Specifications Section 26-1.02A Class 2 Aggregate Base.
- C. Walkway rock or yard ballast gradation shall conform to SCRRA ES2007-02 and AREMA Volume 1, Chapter 1, Section 2.4.4, Table 1-2-2, Standard No. 5 ballast unless otherwise noted.

### **2.03 MATERIAL QUALITY REQUIREMENTS**

- A. Ballast shall consist of crushed stone which is comprised of angular fragments resulting from crushing, by mechanical means, the following types of rocks quarried from undisturbed, consolidated deposits:
1. Granite and similar, phanero-crystalline igneous rock, extrusive igneous rock, or massive metamorphic quartzite or similar rock.
  2. No crushed limestone, dolomites, or gravels shall be allowed.
  3. Furnish prepared ballast that is hard, strong, angular, durable particles of crushed rock containing no carbonates or slag and free from injurious amounts of deleterious substances and conforming to the following requirements of these Specifications.
- B. Material qualities shall be as follows:

<b>PROPERTY</b>	<b>MINIMUM</b>	<b>MAXIMUM</b>	<b>TEST METHOD</b>
Percent material passing No. 200	--	1.0 percent	ASTM C 136 ASTM C 117

Bulk specific Gravity – Rock	2.60	--	ASTM C 127
Absorption - Rock	--	1.0 percent	ASTM C 127
Clay lumps and friable particles	--	0.5 percent	ASTM C 142
Degradation	--	As Noted for Material Type	ASTM C 535 or ASTM C 131
Granite	--	35 percent	(Note 1)
Traprock	--	25 percent	
Quartzite	--	30 percent	
Soundness – (Sodium Sulfate) – 5 cycles	--	2.5 percent	ASTM C 88
Flat or elongated particles (length is equal to or greater than three times the average thickness)	--	5 percent	ASTM D 4791
Durability Test – Procedure A	65	--	ASTM D 3744
Magnesium Carbonate	--	0	ASTM D 3042
Sand Equivalent	50	—	California 217/ASTM D2419

Note 1: Materials having gradations containing particles on the 1 inch sieve shall be tested by ASTM C 535. Materials having gradations with 100% passing the 1 inch sieve shall be tested by ASTM C131. Use ASTM C 535 for Ballast Standard Type 4A and ASTM C131 for Ballast Standard Type 5.

- C. All particles of the ballast shall have been broken by the crusher and must have at least two fractured surfaces.
- D. The aggregate base shall consist entirely of crushed rock with a minimum of 75 percent of the material having at least two fractured faces. No reclaimed asphalt or concrete (Crushed Miscellaneous Base) shall be included in this material.

**2.04 SOURCE QUALITY CONTROL**

- A. Vendor's testing laboratory shall take and perform gradation and other tests on representative samples of ballast, of not less than 150 lbs, from each source of ballast.
  - 1. Perform tests to ensure compliance with these Specifications.
  - 2. Each shipment of ballast shall be accompanied by a certification as specified.

**PART 3 - EXECUTION****3.01 GENERAL**

- A. Comply with the SCRRA Engineering Standards and Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

**3.02 SCHEDULE**

- A. The Vendor providing the materials shall contact SCRRA's Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

- A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

**4.02 PAYMENT**

- A. 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 34 11 16**

## SECTION 34 11 27

### SUB-BALLAST AND AGGREGATE BASE

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. This Section specifies the material requirements and performance criteria for roadway and pathway aggregate base to be furnished in accordance with Contract Documents or required by the Engineer.

##### 1.02 REFERENCES

- A. SCRRA: Engineering Standards, and Track Maintenance Manual, particularly but not limited to SCRRA ES2007-01 and ES2007-02.
- B. American Railway Engineering and Maintenance of Way Association (AREMA): Manual for Railway Engineering.
- C. Caltrans Specifications: Section 26 – Aggregate Bases.

##### 1.03 SUBMITTALS

- A. Samples: As required by the Engineer samples of not less than 150 lbs. Samples shall be furnished by the Vendor or may be obtained independently by the Engineer's representative for testing to determine whether the material delivered to the site is in compliance with the Specifications.
- B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.

##### 1.04 QUALITY ASSURANCE

- A. Testing shall be performed by Vendor's independent certified testing laboratory approved by SCRRA.
- B. The Vendor shall provide laboratory certification that ballast Material meets the Specifications of this Section.
- C. If the Vendor observes material not suitable for work, or not in compliance with this part, SCRRA must be notified within three (3) hours of discovery of condition.
- D. The product delivered shall be from the same source from which samples were tested and found to conform to the Specification and shall be of the same type and quality of that which was tested.

## **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Prepared sub-ballast and aggregate base shall be handled in such a manner that it is kept clean and free from segregation, and when delivered, the sub-ballast and aggregate base shall be clean and free from rubbish or any substance, which might foul the ballast.
- B. Blending, stockpiling, and other production and handling operations must be managed by the Vendor to minimize segregation of finished product.
- C. Stockpiling operations shall minimize breakage or excessive fall in stockpiling operations.
- D. The movement of wheeled or tracked machines over stockpiled or installed Materials shall be limited.
- E. The material will be supplied to the SCRRA in accordance with the delivery requirements, FOB Destination. The material when purchased is to be delivered to the six-county Los Angeles area at a place designated by the SCRRA representative. The delivery must be coordinated with SCRRA representative prior to shipping and loading. Orders can be combined and shipped on or before the delivery scheduled with approval by SCRRA. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.
- F. Vendor shall be responsible for unloading sub-ballast and aggregate base under the direction of Authority or authorized representative.

## **PART 2 - PRODUCTS**

### **2.01 MATERIAL REQUIREMENTS**

- A. Sub-ballast shall conform to the gradation and quality requirements for SCRRA ES2007-02 and Caltrans Specifications Section 26-1.02A, Class 2 Crushed Aggregate Base, 3/4" Maximum. In addition, the aggregate shall consist entirely of crushed rock with a minimum of 75 percent of the material having at least two fractured faces. No reclaimed asphalt or concrete (Crushed Miscellaneous Base) shall be included in this material.
- B. Aggregate base shall be the same material as sub-ballast.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Comply with the SCRRA Engineering Standards and Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.



- B. Placing, and spreading of sub-ballast and aggregate base shall meet the requirements stated in Caltrans Standard Specifications, Section 26-1.03, Construction.
- C. Compaction of sub-ballast shall be at minimum compacted to 95% relative compaction.
- D. Finished surface shall not vary from grade shown in plans by 0.05 foot.

### **3.02 SCHEDULE**

- A. The Vendor providing the materials shall contact SCRRA's Material Management Supervisor, 48 hours prior to the date of delivery.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Vendor for Work of this Section.

### **4.02 PAYMENT**

- A. 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 34 11 27**

**SECTION 34 11 33**  
**CONCRETE RAILROAD TIES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section specifies the material requirements and performance criteria for production and inspection of mono-block, pretensioned, prestressed concrete ties for standard gage track (4' – 8 1/2") to be furnished in accordance with the specifications and SCRRRA Engineering Standards ES2402, ES2403, ES2406 or ES2407 as appropriate.
- B. Work included in this Section encompasses work necessary for the manufacturing and production of concrete crossties and guardrail concrete cross ties both with or without neoprene pads.
- C. 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 34 72 00 - Trackwork.
  - 4. Section 34 72 20 - Track Shifting, Relocation, and Resurfacing.

**1.02 REFERENCES**

- A. SCRRRA Engineering Standards:
  - 1. ES2402, ES2403, ES2406 or ES2407 as appropriate.
- B. American Concrete Institute (ACI):
  - 1. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
  - 2. 214R, Standard Practice for Evaluation of Strength Test Results of Concrete.
  - 3. 301, Specifications for Structural Concrete.
  - 4. 318, Building Code Requirements for Structural Concrete.

- C. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering, Volume 1, Chapter 30, Part 4.2.3 Duggan Concrete Expansion Test.
  
- D. ASTM International (ASTM):
  - 1. A421, Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete.
  - 2. A536, Standard Specification for Ductile Iron Castings.
  - 3. A881, Specification for Steel Wire, Deformed, Stress-relieved or Low-relaxation for Prestressed Concrete Railroad Ties.
  - 4. A886, Standard Specification for Steel Strand, Indented, Seven-Wire Stress-Relieved for Prestressed Concrete.
  - 5. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
  - 6. C33, Standard Specification for Concrete Aggregates.
  - 7. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  - 8. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens).
  - 9. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
  - 10. C150, Standard Specification for Portland Cement.
  - 11. C191, Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle.
  - 12. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
  - 13. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
  - 14. C295, Standard Guide for Petrographic Examination of Aggregates for Concrete.
  - 15. C359, Standard Test Method for Early Stiffening of Hydraulic Cement (Mortar Method).
  - 16. C430, Standard Test Method for Fineness of Hydraulic Cement by the 45- $\mu$ m (No. 325) Sieve.
  - 17. C457, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete.

18. C494, Standard Specification for Chemical Admixtures for Concrete.
  19. C617, Standard Practice for Capping Cylindrical Concrete Specimens.
  20. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
  21. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
  22. C403, Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
  23. C1017, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
  24. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
  25. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
- E. Precast/Prestressed Concrete Institute (PCI):
1. MNL 116, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

### 1.03 DEFINITIONS

- A. The word "Inspector" in this Specification shall mean the duly authorized representative of SCRRA.
- B. The word "Vendor" used in this Specification shall mean the Contractor.
- C. The word "manufacturer" in this Specification shall mean the manufacturer of concrete ties.
- D. The word "supplier" in this Specification shall mean a supplier of materials or components for use in the concrete ties.
- E. The word "source" in this Specification shall mean a plant where a material or component used in the concrete ties, is produced. For aggregates, the word "source" shall mean the strata or quarry face from which the aggregate is obtained.
- F. The word "bed" in this Specification shall mean a prestressing bed with forms placed end to end. Each bed is only one form wide.
- G. The word "form" in this Specification shall mean a battery form, one tie long, with 5 to 8 cavities in which ties are cast upside down.

- H. The word "line" in this Specification shall mean a series of ties end to end on a prestressing bed. Each line is only one tie wide.
- I. The words "long line process" in this Specification shall mean ties being, made on a bed with at least ten forms end to end and on which the prestressing wires are tensioned between fixed abutments, independent of the forms, and prior to placing concrete.
- J. The words "outside testing laboratory" in this Specification shall mean a testing laboratory, independent of the manufacturer, which conforms to ASTM E994 and is approved by the Engineer.

#### 1.04 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00, Submittal Requirements:
  - 1. Compliance: Manufacturer's certification that the materials delivered are in compliance with the specification.
    - a. Certification that the proposed concrete tie and shoulder inserts will satisfy all test requirements as specified herein.
    - b. Certification shall include qualified laboratory test results, calculations and performance reports from a proven fastener design with five (5) years of operational service.
  - 2. Tests:
    - a. Certified test results, as required to demonstrate compliance of materials specified herein shall be submitted to the Engineer. The test results for the following items shall be supplied:
      - 1) Cement.
      - 2) Aggregates.
      - 3) Water.
      - 4) Concrete.
      - 5) Rail Seat Pads.
      - 6) Fasteners.
      - 7) Electrical Properties.
      - 8) Tie Testing.
  - 3. Design Analysis:

- a. A complete design analysis of the proposed tie and associated hardware, verifying the tie's capability to pass the test requirements contained in the Specifications and verifying the adequacy of the materials for their intended use.
- b. Design submission shall include:
  - 1) Structural detail Drawing(s) of the proposed tie and fastening assembly.
    - a) The Drawing shall include tie configuration, prestressed strand size and location, and details of the shoulders with their fabrication tolerances.
  - 2) All structural calculations shall be based upon current industry standards for prestressed concrete design and the ACI standard requirements applied as follows:
    - a) Calculations shall include moment analysis for the tie under no-cracking conditions and shall consider all long-term permanent prestress losses.
  - 3) Concrete batch compositions:
    - a) Submission shall include physical and chemical composition of the batch; including, type and source of cement admixtures used, source and gradation of aggregates, source and quality assurance of water, curing, procedure, including concrete strength at prestress transfer, and separation of the tie from the form.
    - b) It is the Vendors responsibility to ensure that the concrete composition and quality is suitable for its intended purpose.
  - 4) Specifications for pretensioning tendons:
    - a) Documentation confirming the quality of material used in these elements.
  - 5) Cure time:
    - a) The length of cure time necessary for the tie to reach 7,000 psi strength prior to delivery for placement in track.
4. Submit Shop Drawings prepared by the manufacturer for the standard "Fastclip" concrete ties and the guardrail equipped "Fastclip" concrete ties both with and without neoprene pads, if required.

5. Submit to the Engineer Shop Drawings prepared by the manufacturer for the forms and for the gages.
  - a. Forms and gages shall not be used until the Plans have been approved by the Engineer.
6. Before production commences, submit a Quality Control Manual prepared by the manufacturers for approval by the Engineer.
  - a. This Manual shall include the following details:
    - 1) Management organization.
    - 2) Responsibilities of production and quality control personnel.
    - 3) Plant Standards.
    - 4) Checks to be carried out by production personnel.
    - 5) Inspection and testing to be carried out by quality control personnel.
    - 6) Procedures for approving sources of materials and for order in materials.
    - 7) Procedures to insure that only materials complying with these Specifications are used.
    - 8) Procedures to insure all measuring equipment is properly calibrated.
    - 9) Procedures to insure that ties are not shipped until acceptance load testing is complete and that rejected ties are clearly marked and segregated from good ties.
    - 10) Quality Audit procedures.
  - b. The Manual shall be revised or amended whenever there are changes in personnel, responsibilities, or other items contained in it.
7. Submit the Quality Control Program and the Production Program specified under "Quality Assurance and Quality Control" herein.
8. Submit written reports to the Engineer prepared by the manufacturer documenting strict adherence to the Quality Control Program and the Production Program.

## 1.05 QUALITY ASSURANCE

- A. Qualification of the Manufacturer:

1. The manufacture shall have a minimum of 5 years experience, in a fixed location, of the large-scale manufacture of pretensioned prestressed concrete railroad cross-ties by the long line process.
  - a. The manufacturer's existing plants in the USA shall have been certified under the PCI Plant Certification Program.
  - b. If the manufacturer's existing plants are outside the USA, they shall have been certified by the equivalent National Certification Organization for that country.
2. The manufacturer shall show to the satisfaction of the Engineer that he has, or can obtain, the necessary and proper equipment, tools, facilities and means, and that he has the experience, ability and financial resources to perform the work within the time specified and to the quantity standards required.
3. Ties shall be manufactured by the long line process with 5 to 8 lines per bed.
4. If the manufacturer produces the ties in a new plant, that plant shall be certified under the PCI Plant Certification Program within 6 months from the start of production.
5. The requirements of ACI 301 and PCI MNL 116 shall apply except where other requirements are stated in these Specifications.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Concrete ties shall be shipped in open-top cars or flat bed truck trailers.
  1. Ties shall be securely braced for transportation to prevent any movement that will cause damage.
  2. Ties shall be shipped in a horizontal position and braced with spacer blocks in such a manner that the top surface or cast-in-place hardware does not contact ties loaded above.
  3. Ties shall not be loaded higher than the top of the cars and not more than six layers deep.
- B. Ties must be delivered, unloaded, and neatly stockpiled as necessary on the project site by the Vendor.
  1. When handling ties in the plant, yard or at the delivery site, ties must not be dropped or otherwise damaged.
  2. Ties must be stacked on firm level ground, not more than 10 ties high and supported on dunnage at the rail seats only.



**PART 2 - PRODUCTS****2.01 GENERAL - MATERIALS**

- A. The manufacturer shall only use materials from sources approved by the Engineer.
  - 1. For cement, the source of clinker and the source of the ground cement will be approved by the Engineer.
  - 2. All tests for cement and aggregate shall be completed in accordance with this Specification before approval of materials is requested from the Engineer.
- B. Adequate time shall be allowed for the Engineer to approve new sources.
  - 1. Trial concrete mixes shall be cast at least 90 days prior to approval being requested.
- C. For aggregates to be supplied from a new source that has not been previously tested, a minimum period of 224 days shall be required for testing to ASTM C227 prior to approval being requested.
  - 1. Alternatively, 70 days shall be allowed for the Osmotic Cell Test. SCRRA will accept previous test results on these aggregates from a qualified laboratory performing these tests as required to the standards of the appropriate ASTM which has been supervised, signed and sealed by a California Registered PE or Geologist.

**2.02 CONCRETE**

- A. The minimum 28-day-design compressive strength of concrete used for concrete ties shall be 7000 psi as determined in accordance with ASTM C39.
  - 1. The test cylinders shall be made and stored as specified in ASTM C31.
- B. Batching and Mixing:
  - 1. Aggregates and cement shall be measured by weight.
    - a. The weight of aggregate shall be based on a saturated surface dry condition corrected for free moisture.
  - 2. Water shall be measured by weight or volume and admixtures shall be measured by volume.
  - 3. Each batch of concrete shall be mixed separately in a pan mixer or approved horizontal drum mixer located at the site of the concrete tie manufacturing, process.
  - 4. No water shall be added to concrete after discharge from the mixer.

5. The quantity of each material used in each batch of concrete shall be automatically recorded.
- C. Proportioning:
1. Mix proportions shall be developed using the method in ACI 301, Section 3.9. The cement content shall be not less than 600 lbs/cy.
- D. Temperature: The temperature of freshly mixed concrete shall not exceed 90° F.
- E. Curing:
1. Immediately after placing and consolidating, the concrete, the exposed surface shall be protected from rapid evaporation.
  2. Concrete shall not be placed in forms whose temperature is less than 40° F and the concrete temperature shall not be allowed to fall below 50 ° F between casting, and transfer of prestress.
  3. If heat curing is used, the forms may be preheated to avoid cooling of the concrete after placing but the temperature of concrete shall not exceed 90 ° F during the first three (3) hours and 105 ° F during the first four (4) hours (ASTM C403).
  4. The rate of temperature rise in the concrete shall not exceed 35° F per hour and the maximum concrete temperature shall not exceed 158° F.
    - a. Transfer of prestress shall not be carried out at a concrete temperature above 135° F.
    - b. The heating method used shall be such that all ties in a bed are at a similar temperature.
  5. During curing, the temperature at the center of the rail seat cross section of one tie in each bed shall be automatically recorded.
- F. Testing Fresh Concrete:
1. The first batch on any bed shall be tested in accordance with this Specification and if this requires no adjustment to the mix, a further test shall be made after approximately 25 cubic yard has been poured.
    - a. If the first batch requires adjustment to the mix each subsequent batch shall be tested until no further adjustment is necessary and then a further batch shall be tested after approximately 25cubic yard has been poured.
  2. Slump:
    - a. When measured in accordance with ASTM C143, the slump shall not exceed 2 inches when concrete is placed in the forms.

- b. A minimum of two measurements of slump shall be made, on separate batches of concrete, for each bed cast or each 50 cubic yard concrete whichever is less volume of concrete.
3. Air Content: Air entrainment of the concrete shall comply with the following table in areas that are subject to freeze/thaw conditions:

PERCENT AIR ENTRAINMENT STAGE	AIR CONTENT
Plastic Concrete	4.5% $\pm$ 0.7%
Cured Concrete	3.5% $\pm$ 0.5%

G. Testing Hardened Concrete:

1. Compressive Strength:
  - a. When measured on 4" x 8" cylinders capped in accordance with ASTM C617 and tested in accordance with ASTM C39, the minimum compressive strength shall be:
    - 1) At transfer of prestress: 4500 psi.
    - 2) At 28 days: 7000 psi.
  - b. The minimum number of test cylinders per bed shall be:
    - 1) For transfer strength: 4.
    - 2) For 28 day strength: 3.
  - c. The cylinders shall all be made from one batch of concrete and the slump and air content shall also be measured on the same batch.
  - d. The cylinders shall be cured with the ties until transfer of prestress, in such a way that the temperature of the cylinders is with +0° -15° F of the temperature of the ties.
  - e. After transfer of prestress, the 28-day cylinders shall be cured in accordance with ASTM C192.
2. As an alternative to cylinders 4 inches cubes may be used to measure the compressive strength at transfer of prestress.
3. Two cylinders shall be tested for transfer strength.
  - a. If either result is less than 4500 psi, curing shall be continued for at least a further one (1) hour.
  - b. No bed shall be detensioned until at least two cylinders achieve a strength of 4500 psi.

- c. If all transfer cylinders are tested without conforming to this requirement the bed may be detensioned if at least one cylinder achieves 4500 psi.
  - d. An additional set of ties from one form shall then be acceptance load tested.
  - e. If no transfer cylinders achieve 4500 psi, the bed may be detensioned providing, all ties are acceptance load tested.
4. The strength at 28 days shall be satisfactory if the average of three cylinders is not less than 7000 psi and no individual result is less than 6500 psi.

H. Durability:

1. One tie shall be selected at the start of production and thereafter every three months, for air void content and durability factor tests by an outside testing laboratory.
2. The air void content shall be measured in accordance with ASTM C457 on the top, center and bottom of a cross section slice cut from the rail seat of a tie.
  - a. The measured air void content shall be not less than 3.0 percent and the air void spacing factor shall not exceed 0.008 inch.
3. The durability factor shall be measured in accordance with ASTM C666 on a minimum of 4 prisms of concrete taken adjacent to the samples used for the durability tests as required by this Specification.
  - a. The durability factor shall not be less than 90 percent.
4. The frequency of testing, for durability shall be increased at the Engineer's request if there is evidence that not all ties satisfy the requirements of this Specification.

I. Chloride:

1. The water-soluble chloride content of the concrete shall not exceed 0.06 percent expressed as chloride ion by weight of cement.
  - a. This shall be measured by an outside testing laboratory on fresh concrete or on individual materials in the mix when mix proportions are developed in accordance with Paragraph entitled "Proportioning" in the Article "Concrete" of this Specification and thereafter, by tests at three monthly intervals which include materials from all sources in use.

J. Alkali - Silica Reactivity:

1. The composition of the cement, fine aggregate shall be analyzed and tested in accordance with ASTM C33, ASTM C227, and the "Duggan" Concrete Expansion Test so as to ensure that the resulting combination does not produce a concrete subject to deleterious expansion resulting from an alkali-silica reaction.
  - a. These tests are to be repeated every 6 months, from each source, unless otherwise defined in this Specification.
  - b. In addition, whenever a component or source is changed, new tests will be performed on these components or sources.

## 2.03 CEMENT

- A. Cement shall conform to ASTM C150, and low alkali.
  1. Cement alkali content of  $\text{Na}_2\text{O}$  equivalent ( $\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$ ) shall be as low as possible and not greater than 0.6 percent.
  2. The false set penetration, when tested in accordance with ASTM C359, shall be not less than 50 mm at intermediate times and 40 mm after remix.
- B. Separate random samples of cement shall be taken each day to represent the cement used on each bed.
  1. Each sample shall be not less than 1 gallon and shall be clearly identified with the date and bed number.
  2. Each sample shall be kept in air-tight container until the corresponding 28-day cylinder tests have been carried out and results accepted by the Engineer.
- C. Not more than two sources of clinker or ground cement shall be used by the manufacturer during any one-month.
  1. Cement from each source shall be clearly identified and stored in separate weather tight silos.
  2. If two sources of cement are used on one bed, the tests in Paragraph 2.02E herein shall be performed on the first batch of concrete made with each cement and if no adjustment to either mix is required, testing shall continue as single design as required in Paragraph 2.02E. herein Strength tests as required in Paragraph 2.02.F.1 herein shall also be conducted on concrete made with each type of cement.
- D. Cement mill certificates shall be provided weekly by each supplier and shall include the results of the following tests on cement delivered during that week.
  1. Under no circumstances shall substitution of cement be permitted unless it has been pre-qualified through the tests listed in this Section.

- a. Fineness by air permeability (ASTM C204).
  - b. False Set (ASTM C359) - Penetration at 3, 5, 8, and 11 minutes and remix.
  - c. Setting Time (ASTM C191).
  - d. Compressive Strength (ASTM C109) at 1 day, 3 days, and 7 days.
  - e. Chemical Analysis (ASTM C114) - INCLUDING  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{MgO}$ ,  $\text{SO}_3$ ,  $\text{K}_2\text{O}$ ,  $\text{Na}_2\text{O}$  and calculated alkalis as  $\text{N}_2\text{O}$  equivalent,  $\text{C}_3\text{S}$ ,  $\text{C}_2\text{S}$ ,  $\text{C}_3\text{S}$ ,  $\text{C}_4\text{AF}$ .
  - f. Residue on 325-mesh sieve (ASTM C430).
- E. At least once during every three months, a randomly chosen sample of cement from each source used shall be analyzed for alkali content in accordance with ASTM C114 by an outside testing laboratory.

## 2.04 AGGREGATES

- A. Both fine and coarse aggregates shall meet the requirements of the AREMA Specifications for Aggregates, Part 1, Section 1.3, Chapter 8 of the AREMA Manual.
- B. Aggregates shall be natural aggregates complying with ASTM C33 Class 4S. The maximum combined coarse aggregate percentage wear shall not exceed 39 percent.
- C. The manufacturer shall provide evidence that concrete containing aggregate from the proposed source with a cement content and alkali burden similar to the job mix, has a satisfactory service history of at least 5 years. This evidence shall include structures requiring a Class 4S aggregate.
- D. The maximum size of aggregate shall be  $\frac{3}{4}$ ". If the coarse or fine aggregate is supplied in more than one size, each size shall be stored separately.
- E. Washed aggregate shall be allowed to drain, in stockpiles, before use. All aggregates shall be free from ice when used.
- F. In addition to the requirements of ASTM C33, the following tests shall be conducted by an outside testing laboratory.
  1. Petrographic examination to ASTM C295. Examination shall be repeated on aggregate from each new source.
  2. Evaluation of potential alkali reactivity to ASTM C227 or ASTM C1293.
    - a. A separate test shall be conducted with each job cement and the results shall conform with ASTM C33 at three and six months.
    - b. This shall be repeated every 6 months for each source.

- c. When there is insufficient time for testing, to ASTM C227 or ASTM C1293, potential alkali reactivity may be evaluated by the Osmotic Cell Test\* developed by PCA.
  - 1) The flow rate at 30 days shall not exceed 1.5 mm per day. Proceedings 6th International Conference on Alkalis in Cement, Danish in Concrete Institute, Copenhagen, 1983.
- 3. Evaluation of potential alkali carbonate reactivity:
  - a. Aggregates containing carbonate shall be tested in accordance with ASTM C586.

## 2.05 WATER

- A. Water in mixing concrete and washing aggregates shall be potable and free of injurious amounts of oil, acid, alkali, inorganic matter, or other deleterious substances, that may be harmful to concrete or steel as specified in AASHTO T-26.
  - 1. In addition, the mixing water, including that portion of the mixing water contributed in the form of free moisture on the aggregates, shall not contain a chloride ion content greater than 400 ppm.

## 2.06 ADMIXTURES

- A. Chemical admixtures for concrete shall conform to ASTM C494.
  - 1. Admixtures containing chlorides, fluorides, sulfides, or aluminum powder shall not be used.
  - 2. Only liquid admixtures shall be used.
  - 3. Air-entraining, admixtures shall conform to ASTM C260 and contain neutralized Vinsol Resin or other approved natural resins as the active ingredient.
  - 4. Water reducing admixtures shall only be used with the approval of the Engineer. They shall conform to ASTM C494, Types A, B, D, or E.
    - a. Water-reducing admixtures, retarding admixtures, accelerating admixtures, water reducing and retarding admixtures, water-reducing and accelerating admixtures, and high range water reducing admixtures, when authorized by the Engineer, shall conform to ASTM C494 or ASTM C1017 in the case of superplasticizers.
  - 5. Other mineral admixtures shall not be used, except for Class F Flyash as noted below, unless mix and quality control program are specifically approved by the Engineer.

6. Class F Flyash, if used, shall conform to ASTM C618. The properties shall not exceed the following:
  - a. 1.5 percent available alkalis and 6 percent loss on ignition.
  - b. Mill test certificates shall accompany each lot of Class F Flyash used in tie production in order to ensure consistency.
  - c. The combined mix design with admixtures, if used, shall be tested using ASTM C1567 on the proposed job mix to verify alkali-silica reaction (ASR) potential.

## **2.07 PRESTRESSING TENDONS**

### **A. General:**

1. Prestressing shall be indented wire strand or stress relieved wire.
2. The wires shall comply with ASTM A881 or stress relieved wire complying with ASTM A421.
3. The minimum tensile strength of the wire shall be 225,000 psi.
4. Strands for pretensioning tendons shall conform to ASTM A886.
5. All tendons shall be thoroughly cleaned of drawing lubricants before shipment.
6. Tendons from one source only shall be used on each bed.
7. Tendons shall not be contaminated with mud, oil, grease, or chloride salts.
8. Loose rust shall be removed during stringing and tendons pitted due to corrosion shall not be used.

### **B. Pretensioning:**

1. During stringing, tendons shall not become contaminated with form release agent.
2. Each tendon shall be individually tensioned with the same initial force of between 5 percent and 20 percent of the final force using, a hydraulic jack.
  - a. The final force shall then be applied by multiple tensioning with hydraulic jacks.
  - b. The force shall be measured by pressure cases located immediately adjacent to each jack and be measured by elongation.
  - c. The forces measured by the two methods shall agree to within 5 percent.



- C. Detensioning:
1. Stress transfer shall be performed in a controlled manner with hydraulic jacks.
    - a. The forms shall be free to move and the stress in all tendons shall be transferred at the same time and the same rate.
    - b. No tendon shall be cut until it is completely detensioned.
  2. If any tendons break during, curing, all ties shall be load tested in Rail Seat Positive in accordance with Paragraph entitled "Acceptance Load Testing" in Article "Testing of Ties", starting with the ties from the form adjacent to the abutment where the tendon broke and moving towards the other abutment, when a point on the bed is reached at which all ties from one form pass the test, the remaining ties shall be accepted without further load testing.

## 2.08 RAIL FASTENING COMPONENTS

- A. Rail fastening system shall be resilient, thread-less and adjustable in three steps without dismantling the fastener. The three steps shall be:
1. Retracted: Permits installation or removal of rail.
  2. Intermediate: Permits longitudinal rail movement.
  3. Clamped: Provides full rail clamping force.
- B. Fasteners shall be comprised of as few components as economically and technically feasible for ease of assembly, disassembly, and maintenance. The rail clips, rail seat pads, and insulators shall be furnished by rail clip manufacturer and shall be compatible with concrete tie shoulders.
- C. Configure fasteners so that the rail clip can be installed or replaced in the field by one person using standard readily available track tools. Clips shall also be capable of being installed by commercially available automated equipment.
- D. Configure fasteners so that when the rail clips are retracted, the rail may be lifted vertically until it is completely free of the fastener without disturbing the horizontal or vertical alignment of the fastener.
- E. Fasteners shall have, on both sides of the rail base, a positive means of preventing more than 1/8 IN total lateral movement of the rail base relative to the fastener in case of failure or loosening of one or both rail clips. The positive means shall extend at least 3/8 IN above the base of rail in the installed position.
- F. Fasteners shall be Pandrol "Fastclip" or approved equal. Rail clips, insulators and tie pads shall be pre-assembled on cross tie at manufacturer's plant.
- G. Rail Clips:

1. Rail clips shall not be dependent on elastomeric components in torsion. The clips shall be reusable after removal through repeated applications without any effect on the operating performance of the system.
2. The minimum vertical hold down force for spring clips shall be 2,500 LBS with total minimum force of 5,000 LBS per rail fastener assembly.

H. Insulators:

1. An insulator shall be used between the rail clip, shoulder insert and the rail to position rail to the proper gauge, provide electrical insulation, reduce abrasion, and transfer the rail loading to the rail clip and shoulder insert.
2. The insulator shall be capable of withstanding degradation from oxidation, water, alkali, petroleum oils, synthetic lubricants, and sunlight without having detrimental effect on the performance of the insulator.
3. Insulator dimensions shall be appropriate to provide standard gauge dimension.
4. Insulators for different uses (adaptive insulators) shall be of different colors or different appearance for ease in identification.

I. Rail Seat Pads:

1. Provide rail seat pads compatible with the rail fastening system with a shape which provides positive means of preventing movement of the pad parallel to the rail. Pads must comply with SCRRRA Engineering Standard ES2363.
2. Alternate designs of rail seat pads shall be considered, provided they have successful history of performance of at least three years service under comparable service conditions.
  - a. Any alternate design must be specifically approved by the Engineer.
  - b. Submit results of industry standard tests concerning the above properties.

J. Iron Shoulders:

1. Iron Shoulders shall be Pandrol cast shoulders for "fast clip" or approved equal, sized for 136 lbs., 6" IN base rail dimension, with adaptive insulators, pads, and clips
2. Ductile iron shoulders shall be obtained by the manufacturer and shall conform to ASTM A536 Grade 60-40-18 or 65-45-12.
  - a. They shall be marked with the part number, supplier's identification and pattern number.

- b. At least four Y block specimens shall be cast from each heat, or in continuous casting, from each four-hour period.
  - c. All specimens shall be heat treated under the same conditions as the shoulders they represent.
  - d. Tension test specimens with a cage length of 2 inch shall be machined from the Y blocks and one tension test shall be made for each heat or each four-hour pour period.
  - e. If the elongation and tension test results do not conform to ASTM A536, a further specimen shall be tested and if this fails the cast shall be reheated or rejected.
  - f. The shoulders and test specimens may not be reheated more than once.
    - 1) After reheating, two test specimens shall be tested.
    - 2) If either of these fails to conform to ASTM A536, the cast shall be rejected.
  - g. The shoulders shall be free from burned-on sand, cracks, cavities, injurious blowholes and other defects.
    - 1) All fins shall be removed from the vertical faces of the head of each shoulder.
    - 2) Fins across the top of the head shall not exceed 1/32 inch and below the head, fins shall not exceed 1/16 inch.
    - 3) At gates, there shall be no cavity in the shoulder more than 1/8" below the general surface level.
  - h. Go and No Go inspection gages shall be used to check that tolerances conform to the Plans.
    - 1) A sampling plan for Acceptable Quality Levels of 1 percent for major dimensions and 4 percent for minor dimensions shall be used.
    - 2) The manufacturer shall decide which are major and minor dimensions in consultation with the Engineer (through the Vendor).
- 3. Iron shoulders shall be free of mud, oil, loose rust and other contamination when cast into ties. They shall be rigidly secured in the forms during casting and shall not move within the concrete when the securing device is released.
  - 4. Location within the ties shall comply with the tolerances on the tie Plans.

5. Ductile iron shoulders shall conform to the dimensions on the Plans issued by the fastening clip suppliers.
- K. Guard Rail Inserts: Inserts for guardrail concrete ties shall be as shown on SCRRA Engineering Standards ES2406 or ES2407 or approved equal.
- L. Neoprene Pads: Neoprene Pads cast into the bottom of the tie for use on bridge decks in certain applications as indicated in the Contract Documents shall be as shown on SCRRA Engineering Standards ES2403 or ES2407.

## 2.09 TIE DIMENSIONS, CONFIGURATION AND WEIGHT

- A. Dimensions, configuration and weight shall conform to the following:
  1. Alternative designs of concrete ties will be considered if they have the same general profile, and length.
  2. Alternative designs must have a successful history of performance of at least five years service under comparable service conditions.
  3. Any alternative design must be specifically approved by the Engineer.
- B. Dimensions:
  1. General:
    - a. Weight: Maximum weight shall be 750 lbs..
    - b. Base Width: 10-3/8 inch ( $\pm 1/4$  inch).
    - c. Height, at rail seat: 8 inch ( $+3/16$  inch  $-1/8$  inch).
  2. Cross Ties:
    - a. Length: 8 FT 3 inch ( $\pm 1/8$  inch).
    - b. Height, at center of tie: 6-1/4 inch ( $+3/16$  inch  $-1/8$  inch).
    - c. The rail seat shall provide for a cant of 1 in 40 toward centerline of track.
  3. Track Gauge shall be 4" – 8 1/2".

## 2.10 FLEXURAL STRENGTH

- A. Flexural strength performance and test requirements shall comply with Section 4.4, Chapter 30 of AREMA Manual.
  1. Results per Section 4.9, Chapter 30 of the AREMA Manual shall be provided.

2. The minimum flexural performance requirements for the concrete ties shall be as follows:
  - a. Positive rail seat moment of 280 inch-kips static.
  - b. Negative rail seat moment of 146 inch-kips static
  - c. Static center positive moment of 110 inch-kips.
  - d. Static center negative moment of 162 inch-kips.

### **2.11 LONGITUDINAL AND LATERAL RAIL RESTRAINT**

- A. The concrete tie and elastic fastener shall provide longitudinal and lateral rail restraint as specified in Section 4.6 and Section 4.7, Chapter 30 of the AREMA Manual.

### **2.12 ELECTRICAL PROPERTIES**

- A. Each concrete tie, together with its elastic fastening, shall comply with Section 4.8, Chapter 30 of the AREMA Manual.

### **2.13 TESTING OF TIES**

- A. Prior to approval of the concrete tie design, tests specified in Section 4.9, Chapter 30 of the AREMA Manual, unless otherwise modified by this Section, shall be performed at testing facility approved by the Engineer and results provided to the Engineer.
  1. Surface Finishes.
  2. Every tie produced shall be visually inspected.
  3. Two ties which, in the opinion of the Inspector, show the required bottom surface finish and two ties which in the opinion of the Inspector show the maximum allowable rail seat defects shall be set aside as comparison standards for acceptance of ties.
  4. The bottom surface of each tie shall have a rough struck, leveled surface.
    - a. Projections from and indentations into the general level of the surface shall not exceed 3/16 inch.
    - b. The indent pattern shall be approved by the Engineer.
  5. The surface of the rail seat shall have a smooth, formed finish not inferior to the comparison standards.
    - a. No forms, seams or warpage in the rail seat will be allowed.
    - b. The rail seat flatness shall not exceed a 1/32 inch difference across any part of the rail seat.

- 1) When referring to voids and rail seat flatness in the rail seat area, the rail seat will be defined as "area between adjacent shoulders and edge of tie to edge of tie" and the area adjacent to the shoulder and 3/8 IN beyond the face of the front face of the shoulder.
  - 2) Grinding or shaving with a jig is acceptable.
  - 3) Freehand grinding is not acceptable, unless approved by the Engineer.
  - 4) Filling of rail seat voids with fillers is not acceptable.
  - 5) No rubbing, brushing or other treatment shall be used on the rail seat.
6. All ties will require a lateral resistance pattern to be placed on the side of the tie.
- a. The Engineer will review for approval the design, but not provide the design of this pattern.
  - b. The tie shall provide a minimum lateral in a single tie push test of 5,000 pounds.
  - c. The tested tie must be in track on a major heavy haul railroad with adequate ballast depth.
  - d. Proof of the lateral resistance design will be through multiple single tie tests as performed by the AAR.
  - e. The tie manufacturer assumes all responsibility for maintenance and design of these forms and patterns.
  - f. The Engineer will not accept a tie without a proven pattern.
7. Other formed surfaces shall be smooth and holes shall not exceed 1/4 inch in depth and diameter.
- a. Ties with a limited number of holes up to 3/8 inch diameter but not exceeding 1/4 inch in depth will be accepted providing that holes are filled with a mixture of 3 parts washed sand, 1 part cement and 1 part SBR latex measured by volume or other accepted material.
8. Holes in tie ends shall not exceed 3/8 inch diameter and 1/2 inch in depth or 1/4 inch diameter and 1 inch in depth below the general surface level of concrete.
9. Corner breakage at tie ends shall not exceed 1 inch in depth.
10. Ties with visible cracks shall be rejected.

11. Prestressing wire shall not protrude more than 1/8 IN beyond the tie end and shall not have ragged ends, which would be hazardous in handling.
  12. The surfaces where fastening components bear on the iron shoulders shall be 100 percent free from concrete or other foreign materials.
- B. Tie Dimension Inspection:
1. Approved Go and No Go gages shall be used to check the following:
    - a. Out to out shoulder spacing.
    - b. Adjacent shoulder spacing.
    - c. Shoulder height.
    - d. Rail seat cant.
    - e. Rail seat flatness.
    - f. Rail seat wind or warpage.
    - g. Wire location.
  2. A "Go and No Go" gage is the basis for acceptance and rejection. No interpretation of a gage is acceptable.
  3. The inspector may gage as often as is required or as the Engineer feels necessary to QC confidence. If a problem is found then it is the responsibility of the Manufacturer to provide inspection as directed by the Engineer (100 percent if necessary) until the extent of the problem has been determined or the rework has been properly confirmed.
  4. When new forms, modified forms or repaired forms are used, the first tie cast in each cavity shall be checked with Go and No Go gages and normal measuring equipment to insure conformity with dimensional tolerances on the tie Plans.
  5. All ties selected for routine acceptance load testing shall be checked as described in this Specification.
  6. Wire pattern shall:
    - a. Ensure 3/4 inch minimum concrete cover of prestress tendons.
    - b. Be placed accurately to prevent electrical short between embedded fasteners.
    - c. Achieve flexural bending strength in Section 2.10.
  7. Wire pattern for all ties on both ends shall be visually inspected every day.

C. Acceptance Load Testing:

1. All acceptance load testing shall be carried out on the day that detensioning is performed. Vendor must provide sufficient notice to the Engineer so as to allow for SCRRA Inspectors to be present during acceptance load testing.
2. Production Start-up Testing: From the first bed cast under any contract, all the ties from one form, selected at random, shall be load tested as follows:
  - a. Rail seat positive and bond development at one end.
  - b. Rail seat negative at the other end.
  - c. If the ties meet these test requirements, further beds may be cast.
  - d. If any tie fails to meet the test requirements, two further ties shall be taken from the same line and, if either of these ties fails to meet the test requirements, each tie in the line shall be individually tested, excluding the bond development test.
    - 1) One further bed shall then be cast and the test procedure repeated.
    - 2) When the test ties meet these requirements an additional four (4) ties shall be randomly selected from the bed already cast and tested as follows:
      - a) Two (2) ties tested for Tie Center Negative Moment Test.
      - b) Two (2) ties tested for Tie Center Positive Moment Test.
    - 3) If any tie fails to meet test requirements, two further ties shall be taken from the same line.
      - a) If either of the ties fail, then the batch is rejected.
      - b) When the test ties meet all of the production startup testing requirements, further beds may be cast.
3. Routine Production Testing:
  - a. After initial production acceptance testing routine acceptance testing shall be carried out on all beds cast.
  - b. All ties from one form, selected at random from each bed cast, shall be load tested as follows:
    - 1) Rail Seat Positive at one end.



- c. Every sixth (6th) tie selected for test shall additionally be tested as follows:
  - 1) Rail Seat Positive at one end to first crack.
  - 2) Rail Seat Negative at other end to first crack.
- d. If any tie fails to comply with the test requirements in Paragraphs 2.13 C. 3 b. and c. above, two (2) additional ties shall be taken from the same line and all tests repeated.
  - 1) If either of these ties fails the test, each tie in the line shall be tested.
- e. One tie per day shall be selected at random from ties subject to Rail Seat Positive test and additionally tested for bond development.
  - 1) If the tie fails to conform to the requirements of this test, two further ties from the same line shall be tested.
    - a) If either of these fails the test, one tie shall be tested from each bed cast on the same day as the ties, which failed the test.
    - b) No ties from beds with test failure shall be shipped until a test program to identify ties with unsatisfactory bond is agreed with the Engineer and the tests completed.
- f. One tie per day shall be selected at random from ties subject to Rail Seat Positive Test and additionally tested for Tie Center Negative Moment.
  - 1) If the tie fails to conform to the requirements of this test, two further ties from the same line shall be tested. If either of these ties fails, each tie in the line shall be tested.

D. Rail Seat Positive Test:

- 1. The tie shall be supported in a hydraulic testing machine with loading points so arranged that the load is applied at right angles to the base of the tie midway between the supporting pads. Test configuration shall be in accordance with Chapter 30 of the AREMA Manual.
- 2. A test load of 52 kips shall be applied at a rate not exceeding 10 kips per minute and maintained for at least three minutes to permit proper inspection. Both sides of the tie shall be inspected.
- 3. A tie will be considered to have failed the test if at the 52 kips test load, it contains a structural crack when viewed under 5-power magnification. The illumination at the surface shall be not less than 125 FT candles.

4. When a tie is to be tested to first crack loading shall continue, after inspection at the 52 kip load until a crack 1 IN in vertical length is observed. The load shall then be recorded.
- E. Rail Seat Negative Test:
1. The tie shall be supported in a hydraulic testing machine, in accordance with the test configuration in AREMA Manual, Chapter 30.
  2. The testing procedure shall be in accordance with Chapter 30 of the AREMA Manual.
  3. A test load of 29 kips shall be applied at a rate not exceeding 5 kips per minute and maintained for at least three minutes to permit proper inspection. Both sides of the tie shall be inspected.
- F. Bond Development Test:
1. The tie shall be supported in a hydraulic testing machine, in accordance with the test configuration in AREMA Manual.
  2. Dial gages reading, to 0.001 inch shall be attached to the tie at the end being tested, to measure any movement relative to the tie of the outermost wire in each of the bottom corners of the tie.
  3. A test load of 78 kips shall be applied at a rate not exceeding, 5 kips per minute and maintained for a period of five minutes.
    - a. The wire movement shall not exceed 0.001 inch
    - b. If during this test, a structural crack more than 3 inch long occurs, the test tie shall be rejected after completion.
- G. Tie Center Negative Moment Test:
1. The tie shall be supported in a hydraulic testing, machine in accordance with the test configuration in the AREMA Manual.
  2. A test load of 12 kips shall be applied at a rate not to exceed 5 kips per minute and maintained for at least 3 minutes to permit proper inspection. Both sides of the tie should be inspected.
- H. Tie Center Positive Moment Test:
1. The tie shall be supported in a hydraulic testing machine in accordance with the test configuration in the AREMA Manual.
  2. A test load of 8 kips shall be applied at a rate not to exceed 5 kips per minute and maintained for at least three minutes to permit proper inspection. Both sides of the tie shall be inspected.

- I. Electrical Short:
  - 1. Each tie tested in accordance with Paragraph 2.13.C. herein shall be checked for shoulder to shoulder direct electrical shorts under 10 Vdc using an Ohm Meter.
    - a. The resistance shall not be less than 100 ohms.
  - 2. If any tie fails this test, all ties from the same line shall be individually tested.
- J. Test Reports:
  - 1. The Vendor must submit a monthly manufacturer's test report to the Engineer. This shall include:
    - a. Number of good ties cast.
    - b. Number of reject ties cast and reasons for rejection.
    - c. Concrete compressive strength test results at transfer and at 28 days.
    - d. Average and standard deviation of the 28-day compressive strength results.
    - e. Percentage probability of 28-day compressive strength results failing to meet the minimum specified strength and the actual number of failures.
    - f. Tie first structural crack loads, rail seat positive and rail seat negative.
    - g. Average and standard deviation of the first crack loads.
    - h. Percentage probability of the first crack loads failing to meet the minimum specified load and the number of failures.
    - i. The 28-day Compressive Strength results shall also be presented as frequency histogram.
    - j. The Average 28-Day Strength results, Average first Crack Loads and Percentage probability of failing figures shall also be plotted on graphs showing, the corresponding results for the previous 12 months or since production started, whichever is the shorter period.
  - 2. The manufacturer shall retain for a period of 10 years all test certificates provided by suppliers and outside testing laboratories.
    - a. Results of all inspection and testing carried out by the manufacturer shall also be retained for 10 years.

**2.14 INSPECTION**

- A. Inspectors shall have access, during any and all working hours, to all parts of the manufacturer's plant involved in tie production and to those parts of suppliers plants engaged in producing materials or components for use in the ties.
- B. Inspectors shall access to the results of all tests carried out by the manufacturer, suppliers and outside testing laboratories.

**2.15 PLANT AND YARD HANDLING**

- A. When handling ties in the plant or yard, they shall not be dropped or otherwise damaged.
  - 1. Ties shall be stacked on firm level ground, not more than 20 ties high and supported on dunnage at the rail seats only.

**2.16 IDENTIFICATION**

- A. Each tie shall be marked with indented or raised letters or numerals to identify the manufacturer, SCAX designation, form designation and date/month/year of manufacture as detailed on the SCRRRA Engineering Standard Plans ES2402, ES2403, ES2406 or ES2407 as appropriate.

**PART 3 - EXECUTION****3.01 QUALITY CONTROL**

- A. Quality Control:
  - 1. Testing and inspection shall conform to AREMA Manual, Volume 1, Chapter 30, unless otherwise modified by these Specifications. The cost for testing of materials to be performed by an outside agency shall be provided by the manufacturers and will be included in unit price in the schedule.
  - 2. Ties may be inspected by the Engineer at suitable and convenient places either at points of shipment or destination.
  - 3. The Engineer reserves the right to examine any equipment used for any manufacturing process at any stage of tie production.
  - 4. Material not meeting the requirements of this Specification shall not be used in the work.
  - 5. Quality Control Program:
    - a. Vendor must comply with the following Quality Control Program requirements.

- 1) A quality control program under which the manufacturer will perform sufficient inspection and tests of all items of work, including those by suppliers or subcontractors in order to ensure conformance to applicable standards, Specifications or Plans with respect to materials, workmanship, fabrication, and identification.
- 2) The control plan shall specifically provide for:
  - a) Manufacturer's surveillance (e.g. but not limited to shoulder inserts, wire).
  - b) Drawing- control (changes).
  - c) Mold Certification.
  - d) Document control.
  - e) Inspection procedures - in process and final.
  - f) Production test requirements.
  - g) Segregation and disposition of defective material and products.
  - h) Material and process control in plant identifying critical control points.
  - i) Production equipment and instrumentation calibration, maintenance, and data recording.
  - j) Work procedures and instruction.
  - k) Failure reporting analysis and corrective action.
  - l) Sample plans and quality levels shall conform to Military Standard 105D, AQL Level H unless otherwise stated or approved.
  - m) Raw materials standards and controls.
  - n) Records of test and inspections.
  - o) Time and temperature control.
  - p) Strength testing.
  - q) Storage handling and shipment controls.
  - r) Procedures or tests for determining within 24 HRS that the conditions necessary to achieve the 28-day strength have been met, with a margin of safety.

- s) Quality budget in percentage of contract price.
- t) Assurance that the plant will meet and continue to meet PCI certification.
- u) Quality control organization chart showing all QC personnel and their corresponding contact level at SCRRRA. QC organization must report independently from Production to Project Manager level or above.
- v) The person responsible for quality control shall be independent of production management and shall report functionally to the manufacturing, company's senior management.

6. Production Program:

- a. Vendor must comply with the following Production Program requirements. A complete production program shall include:
  - 1) Plant layout.
  - 2) Form design with tolerances.
  - 3) Raw material requirements.
  - 4) Primary and alternate sources.
  - 5) Material handling.
  - 6) Material placement with tolerances.
  - 7) Curing method.
  - 8) Bond release method.
  - 9) Method of vibration.
  - 10) Pretensioning and detensioning method for strand or wire.
  - 11) Daily production capability.
  - 12) Finished tie inventory plan.
  - 13) Plan for handling ties from finished product to assigned rail cars or alternate transportation arrangements.
  - 14) Flow chart of production process indicating points of control for all significant operations.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Vendor for Work of this Section.

### **4.02 PAYMENT**

- A. 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 34 11 33**

## SECTION 34 11 34

### WOOD RAILROAD TIES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. This Section specifies the material requirements and performance criteria for the Wood Railroad Ties to be furnished in accordance with Contract Documents or required by the Engineer.
- B. Work included in this Section encompasses work necessary for the manufacturing, production and handling of wood switch ties, crossties, and grade crossing ties.

##### 1.02 REFERENCES

- A. AWWPA: American Wood Preserver's Association:
  - 1. M2 – Standard for Inspection of Wood Products Treated with Preservatives.
  - 2. M4 – Standard for the Care of Preservative – Treated Wood Products.
  - 3. P2 – Standard for Creosote Solution.
  - 4. P3 – Standard for Creosote – Petroleum Solution.
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering and Portfolio of Trackwork Plans.
- C. RTA: Railway Tie Association – Specifications for Timber Crossties and Switch Ties.
- D. SCRRA: Southern California Regional Rail Authority (SCRRA) Engineering Standards.

##### 1.03 DEFINITIONS

- A. Anti-Splitting Device – Any device applied to the end or near the end of a tie or timber such as anti-splitting iron, dowel or nail plate to reduce its splitting.
- B. The word "Vendor" used in this Specification shall mean the Contractor.
- C. Boulton Drying Process – A process for drying wood by removing moisture from it by heating in preservatives under sufficient intensity of vacuum to evaporate water from the material at the temperature of the preservative used.
- D. Creep – The time-dependent deformation of a material under load.



- E. Empty Cell – A treatment in which the cell walls in the treated portion of the wood remain coated with preservative, the cell being empty or only partially filled.
- F. Hardwood – One group of trees (deciduous) which have broad leaves. The term has no reference to the hardness of the wood.
- G. Softwood – One of the group of trees (conifers) which have needle-like or scale-like leaves. The term has no reference to the softness of the wood.

#### 1.04 SUBMITTALS

- A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the wood railroad ties have been placed in service.
- B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.
- C. The Vendor shall submit wood railroad ties packaging, loading, shipping, and handling method.
- D. The Vendor shall submit for SCRRA's review and approval quality control and quality assurance plans and related certifications such as ISO 9001, "six sigma" or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality wood railroad ties included in the Schedule of Quantities and Prices.
- E. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing wood railroad ties to Class 1 Freight, passenger or commuter railroads.
- F. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRA's Standard Specifications Section 01 25 00, "Substitution Procedures". The specifications are available on SCRRA's website at [www.metrolinktrains.com](http://www.metrolinktrains.com).
- G. Tests: Certified test results, as required to demonstrate compliance of materials specified herein shall be submitted to SCRRA before any wood ties are used.

#### 1.05 QUALITY ASSURANCE

- A. Vendor's Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program.
- B. Testing and inspection of tie manufacture shall be performed by Vendor in conformance with AREMA Manual, RTA and AWPA.
- C. Ties may be inspected by SCRRA, at suitable and convenient times and places including points of manufacture, shipment, or destination.

- D. SCRRRA reserves the right to examine any equipment used for any process or method of treatment at any stage of tie production.
- E. Material not meeting the requirements of this Specification shall not be used in the Work.
- F. SCRRRA shall have access to Manufacturer's plant during normal working hours and all Project related procurement and production records for inspection any time during the Contract period of performance.

#### **1.06 DELIVERY, STORAGE AND HANDLING**

- A. Tie shall be delivered to any point along the lines of the SCRRRA rail track, as specified in each shipping release. Ties in truckload quantities will be unloaded upon two working day's notice by the Vendor. All unloading operations will take place in active railroad corridors. SCRRRA will assist the Vendor in unloading the ties and will provide necessary equipment for the unloading. SCRRRA will provide an Roadway Worker-In-Charge (RWIC) for on-track safety for the unloading of the ties in the right-of-way. The RWIC will provide job briefing and safety protection to assure the Vendor a safe work environment and all Vendor personnel will be required to attend the job briefing.
- B. Banding of ties by length or grade for shipment shall be done by applying bands in a tight manner (2,500 pounds of tension) to prevent warping, splitting, and slipping during storage or shipment. Two steel bands per bundle (T = 5,450 pounds, 1¼"x0.029" or better) shall be applied within one foot of each end of cross ties or switch ties. Three bands shall be applied to bundles of switch ties. No more than 9 switch ties shall be bundled together. No more than 25 cross ties shall be bundled together.
- C. No steel cables, steel rods, chains, or wooden strips, or any other sticker material shall be shipped in any bundle to SCRRRA.
- D. All rejects shall be marked with an "X" on the end. This is to preclude the accidental shipment of less than grade ties to SCRRRA. Treated ties not handled directly from tram to car shall be carefully and neatly stored. Different size classifications shall be kept separate, and all bundles or stacks shall be marked with SCRRRA, grade or length, and treatment date. Ties shall be stacked to ensure that tie straightness is not impaired during temporary storage. Treated stringers shall be placed underneath all stacks of treated ties. No loose windrows of SCRRRA treated ties shall be allowed. Shipments shall be made from the oldest stacks first. If any ties become excessively bleached during storage, they shall be retreated or replaced by the supplier. Yard drainage conditions shall provide rapid drainage of water from beneath stacks of treated ties. Storage areas shall be kept free of grass and weeds to aid free flow of air and to minimize the possibility of fire. The Vendor shall be liable for all fire damage. A minimum 10 foot weed-free zone shall be maintained around SCRRRA stored inventory at all times. Care shall be exercised in handling of SCRRRA ties for storage or shipment to prevent damage.
- E. Ties shall be stored to avoid contamination of water and soil by the ties.

- F. Long-term tie storage shall not be located within 250 feet of an open road crossing or residences.
- G. Ties temporarily located within 250 feet of a public road crossing or residences shall be covered by an impervious sheet material to control odor and vapor emitted by the crossties by SCRRA.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. Wood railroad ties shall be new and conform to SCRRA Engineering Standards.
- B. Wood railroad ties ordered to the Engineering Standards shall be produced in conformance to these specifications and AREMA Specifications.

### **2.02 WOOD CROSS TIES AND SWITCHTIES**

- A. The following hardwood species can be used for cross ties, switch ties and grade crossing ties:
  - 1. Oak-Hickory Group: Red Oak, White Oak and Hickories.
  - 2. Mixed Hardwoods Group: Gums, Ashes, Cherry, Walnuts, Birches, Maples, Beech, Locusts, Sycamore, Elms and Cypress
- B. The following species are not acceptable:
  - 1. Oak-Hickory Group: Live Oak and Blackjack Oak.
  - 2. Mixed Hardwoods & Softwoods: Douglas Fir, Hem-Fir, Ponderosa Pine, Lodgepole, Pine, Larch, Cottonwood, Willow, Basswood, Hackberry and Poplar.
- C. Oak and elm ties shall be of compact wood throughout the top fourth of the tie.
- D. All cross ties shall be the full length specified; double end trimmed, and should have full body and full face.
  - 1. Ties with greater than 1" of wane within the 20" and 40" rail-bearing sections, when measured from the center of the tie, are not acceptable.
    - a. Thickness and width tolerance shall be not more than 1/4" thinner or narrower than the specified size.
- E. Vendor shall provide a maximum of 50 percent of the ties from oak-hickory species and the remaining 50 percent from mixed hardwoods from list of ties specified under Attachment A, Part E, Section 1 through 4.
  - 1. Oak ties must be air seasoned unless otherwise directed by SCRRA and preapproved and specified in writing.

2. Mixed Hardwoods must be air seasoned unless otherwise directed by SCRRRA and preapproved and specified in writing.

### 2.03 GENERAL TIE REQUIREMENTS

- A. All wooden ties shall be made from sound, straight, live timber and shall be free from any defects that may impair their strength or durability, such as bark, splits, shakes, large or numerous holes or knots, pitch seams, pitch rings, slanting grain or other imperfections.
  1. Decay and/or insect damage in any form is not acceptable.
- B. All ties shall be well sawn on all four sides and cut square at the end to the full dimensions specified.
  1. All ties shall be straight and opposite faces shall be true and parallel, and with all bark entirely removed.
- C. All ties shall be straight.
  1. A tie shall be considered straight when:
    - a. Timber Cross Tie: When a straight line from a point on one end to a corresponding point on the other end is no more than 1-1/2" from surface at all points.
    - b. Timber Switch Ties: When straight line from a point on one end to a corresponding point on the other end is no more than 2" from the surface at all points.
- D. A tie is not well sawn when its surfaces are cut with score marks more than 1/2" deep, or when its surfaces are not even.
- E. The top and bottom of a tie shall be considered parallel, if any difference in the thickness at the sides or ends does not exceed 1/2".
- F. For proper seating of nail plates, tie ends must be flat and will be considered square with a sloped end of up to 1/2", which equals a 1 in 20 cant.

### 2.04 ANTI-SPLITTING DEVICES

- A. Anti-splitting devices are required.
  1. Anti-splitting devices (endplates) shall be multi-nail plates as specified in AREMA Manual, Volume 1, Chapter 30, Part 3.1.6, Specifications for Devices to Control the Splitting of Wood Ties.
    - a. Structural type, Grade "C", 18 gauge galvanized steel, ASTM A653 or better with ultimate strength of 55,000 psi and yield strength of 40,000psi.
    - b. Galvanizing per ASTM A653, G60 coating.

- c. 4-5 teeth per square inch.
  - d.  $\frac{1}{2}$ " to  $\frac{9}{16}$ " length of tooth.
2. This application should enable the plate to hold both vertical and horizontal splits.
  3. End plates shall be applied by a mechanical device capable of squeezing any splits; bringing the tie back to its original (cross section) dimensions prior to application.
  4. End plates for 7"x9" ties are to measure 6" x 7" or 6-1/4" x 7".
  5. No part of the end plate is to be within  $\frac{1}{4}$ " of any side
  6. All anti-split end plates shall have rounded corners and a smooth perimeter.
- B. Embossed on all end plates will be "SCRRA" and manufacturer name followed by the year of manufacture and Treating Plant. End plates will be installed with the letters "SCRRA" upright with the tie oriented with heartwood down.

## 2.05 DIMENSIONS

- A. All cross ties shall have a 7"x 9" cross-section and shall be double end trimmed, unless otherwise ordered.
- B. Length of ties shall be as ordered in each shipping release.
1. Ties will be ordered as 8'-6" or in one (1) foot increments from 9'-0" to 24'-0".
- C. The length, thickness, and width specified are minimum.
1. Ties with thickness and width more than  $\frac{1}{4}$ " thinner or narrower than specified will be rejected. Ties over 1" longer shall be rejected.
  2. Tie dimensions shall not be averaged.

## 2.06 PRESERVATIVE

- A. The preservative shall consist of a mixture of 50 percent by volume of P-1 creosote oil conforming to AWWA Specifications (AWWA P3 and AWWA P4), and 50 percent by volume of an approved petroleum residuum oil.
1. The creosote and oil shall be thoroughly mixed in the working tank until the mixture is of uniform composition. (Note: use of treatment with P-2, 7lbs / cu ft is an approved equal).
- B. The residuum oil shall be approved asphalt base petroleum residuum oil.
1. It shall be free from water and any foreign substance that might interfere with its penetrating qualities.

2. The flash point of the residuum oil shall not be less than 210°F as determined in the Cleveland Open Cup.
3. The viscosity of the residuum oil shall be such that a blend of 50 percent residuum oil and 50 percent creosote shall have a viscosity exceeding 50 seconds Saybolt Universal 180°F.
4. BS&W shall not exceed one (1) percent and the creosote oil mixture shall show no sludge formation upon standing. (Note: AWWA P4 is acceptable as an approved equal for residuum oil).

## 2.07 APPROVALS AND REJECTIONS

- A. Ties with any type of decay will be rejected.
- B. Rejection of ties for holes and knots. All such holes and knots as defined shall be allowed if they occur outside the sections of the tie between 20" and 40" from its middle.
  1. A "large hole" is any hole more than ½" in diameter and 3" in depth within the rail bearing area, or more than 1" in diameter and 3" deep outside the sections of the tie between the 20" and 40" rail bearing area measured from the center of the tie.
  2. "Numerous holes" are any number of holes equaling a large hole in damaging effect. Such holes, whether caused in manufacture or otherwise, will be cause for rejection.
  3. A "large knot" within the rail bearing area is one whose average diameter is more than 1/3 the width of the surface on which it appears. "Numerous knots" are any number, which, in total, equal a large knot in damaging effect. A cluster of knots will be judged as if it were a large knot in damaging effect.
- C. Ties with shake more than 1/3 the width of the tie, and nearer than 1" to any surface, will be rejected.
  1. Fire scar will be considered as bark seam and graded accordingly.
- D. Except in woods with interlocking grain, ties with a slant grain in excess of 1 in 15 will be rejected.
- E. Ties with continuous checks whose depth in a fully seasoned and/or treated tie is greater than ¼ the tie thickness and longer than ½ the length of tie will be rejected.
- F. Any other imperfections that are within the limits of current AREMA and RTA Specifications will be allowed.
- G. A split is a separation of the wood extending from one surface to an opposite or adjacent surface.

1. A split 1/8" wide and 4" long in an unseasoned cross tie is acceptable.
  2. A split more than 1/4" wide and/or 9" long on the face on which it occurs in a seasoned cross tie will be rejected.
  3. Do not count the end as a surface.
- H. Bark seam or pocket is a patch of bark partially or wholly enclosed in the wood.
1. Bark seams will be allowed outside the rail bearing area provided they are not more than 2" below the surface, 1/4" wide, and not more than 5" long.
- I. Ties with heart – checks that go into the tie plate area will be rejected if the check is more than a cumulative 1/2" wide or if the check causes the plate area to be concave or convex.
- J. Holes:
1. Ties having solid holes on any surface within the rail bearing areas greater than 1/2" diameter and greater than 3" deep will be rejected.
  2. Ties having solid holes on any surface outside the rail bearing areas greater than 1" in diameter or greater than 3" deep will be rejected.
  3. Stump pull will be graded the same as a split in the end of a tie.
  4. A stump pull that goes into the interior of the tie more than 5" will be rejected.
  5. Numerous holes are defined as having any number equaling a large hole in damaging effect. Such holes may be caused in manufacture or otherwise.
  6. Mechanically damaged ties shall be replaced by the party that damages the tie.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Comply with the SCRRA Engineering Standards unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

### **3.02 SCHEDULE**

- A. The Vendor providing the materials shall contact SCRRA's Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

### 3.03 PLANT EQUIPMENT

- A. Treating plant shall be equipped with the thermometers and gauges necessary to indicate and record accurately the condition of all stages of treatment, and all equipment shall be maintained in acceptable, proper working condition.
- B. All green ties should be checked periodically for moisture content prior to going in the cylinder.
  - 1. Twenty (20) borings per charge shall be taken from cross ties, so that the moisture content level can be measured, to determine the amount of water that is to be removed from the crossties.
- C. Material shall be conditioned by air seasoning
- D. All material, either under vacuum or at atmospheric pressure, should be handled in such a manner that will not cause degrading, checking, splitting, warping or render it unfit for the service intended.

### 3.04 AIR SEASONING

- A. When air seasoning is used, material shall be treated before it begins to deteriorate. Air seasoned material must be given a preliminary heating in the preservative for not more than three (3) hours at a temperature of not more than 210°F, just before the regular treating operation.
  - 1. All Oak/Hickory ties will be seasoned for approximately 10 months to obtain moisture content not to exceed 45 percent on 2" cores.
  - 2. Mixed Hardwood ties will be seasoned for approximately five months to obtain a moisture content not to exceed 40 percent on 2" cores.

### 3.05 BOULTONIZING

- A. Ties shall only be Boultonized as directed by the SCRRA Director of Engineering and Construction or a designated SCRRA representative. Cross ties and switch ties scheduled for Boultonizing shall be separated by size and species, incised, and forwarded to the tramming station for handling prior to initiation of the drying process. Hickory ties must be Boultonized with oaks. Each layer of ties on the tram shall be separated with one 3/4" steel cable, steel rod, or 1/4" Grade 30 steel chain placed on alternate ends as the layers are built. Switch ties will require two cables, rods, or chains per layer for 9'-12', and three cables, rods, or chains per layer for 13'-16' + lengths. All steel or wooden stickers must be removed prior to shipment to SCRRA.
- B. When boultonizing, the oils shall cover the material in the cylinder.
  - 1. The temperature of the oil during the conditioning period shall not exceed 210°F.



2. When a vacuum is then drawn, it shall be of sufficient intensity to evaporate water from the material at the temperature of the oil.
3. The intensity of the vacuum or the temperature of the oil, or both, shall be adjusted so as to regulate the evaporation of the waters.
4. The conditioning shall continue until the materials are sufficiently heated and enough water removed from the cylinder before an empty-cell process is applied for pressure treatment.
5. The Boultonized process used is to conform to AWPA section C1-00 Section 1.3.3, most recent version.
6. Maximum moisture content is to be 50 percent for oak-hickory and 40 percent in mixed Hardwoods before press cycle begins.

### **3.06 MANNER OF TREATMENT**

- A. Following the conditioning period, material shall be treated by an empty-cell process to obtain as deep and uniform penetration as possible with the retention of preservative stipulated.
  1. The range of pressure, temperature and time duration shall be controlled so as to get the maximum penetration by the quantity of preservative injected.

### **3.07 EMPTY CELL PROCESS (LOWRY AND RUEPING)**

- A. Treatment shall be by the empty cell method with a creosote/coal tar solution or creosote/petroleum (50percent-50 percent) solution in accordance with AWPA Standard P-2, P-3, and P-4. The preservative solution shall be tested monthly according to AWPA Standard A-1 with a copy of the results forwarded to the SCRRRA representative. In no case shall treatment be less than that required for AWPA U1, UC4B.
- B. Material shall be subjected to atmospheric air pressure or to higher initial air pressure of the necessary intensity and duration.
  1. The preservative shall be introduced until the cylinder is filled while the air pressure is being maintained during the filling operation.
- C. The Pressure shall be raised on not more than 210lbs/sq inch.
  1. Material shall be held under pressure until there is adequate preservative injected to meet specified retention.
- D. The temperature of the preservative during the entire pressure period shall not be more than 210°F but shall average at least 180°F.

- E. After pressure is completed, the cylinder shall be emptied speedily of preservative, and a vacuum of not less than 22" at sea level created promptly and maintained until the wood can be removed from the cylinder free of dripping preservative, or;
1. After pressure is completed, and before removal of preservative from tie cylinder, the preservative surrounding the material may be preheated to a maximum of 215°F, either at an atmospheric pressure or under vacuum; the steam to be turned off the heating coils and the leader lines opened immediately after the minimum temperature is reached.
  2. The cylinder shall then be emptied speedily of preservative and a vacuum of not less than 22" at sea level created promptly and maintained until the wood can be removed from the cylinder free of dripping preservative.
- F. At the completion of treatment, material may be cleaned by final steaming (when authorized) at a temperature not more than 240°F for not more than 30 minutes.

### 3.08 RESULTS OF TREATMENT RETENTION

- A. No charge shall contain less than 75 percent or more than 110 percent of the quantity of preservative specified for the class of material except when the character of the wood in any charge makes these requirements impracticable despite treatment to refusal.
1. The amount of preservative retained shall be calculated from readings of working tank gages or scales or weights before and after treatment of loaded trams on suitable track scales, with the necessary corrections for changes in moisture content.
- B. The column of oil preservatives shall be calculated on the basis of 100°F.
1. Calculations of volume or weight shall be made by the use of temperature of specific gravity factor contained in the Volume of Specific Gravity Correction Tables of the AWPA.

### 3.09 PENETRATION

- A. Penetration of ties shall not be less than the following for at least 80 percent of the pieces bored in each charge.

<u>Thickness (inches)</u>	<u>Depth (Inches)</u>	<u>Percent of Sapwood</u>
5 and over	½	90

- B. Penetration of ties shall be determined by boring not less than two (2) ties in each tram in each charge or more than 20 ties per charge.
- C. Penetration of timber and ties shall be determined by boring approximately midway between ends and midway between top and bottom on 7" side of tie.
1. Only material meeting the penetration requirements shall be accepted.

- D. Any charge not conforming to stipulated minimum requirements may be retreated and re-offered for acceptance.
- E. Any holes, which may be bored, shall be filled with tight fitting treated plugs.
- F. Process and preservative to be used on material and retention required shall be as follows, unless otherwise specified, for all ties.

50 percent Oil  
*Process*

50 Percent Creosote  
*Process*

Hardwood	7 ½ lbs or Ref.	L&R
Oak	7 ½ lbs or Ref.	L&R or Bethel

- G. Retention will be determined by gauge. The amount of preservative solution retained shall be determined from readings of working tank gauges or scales made before and after treatment. The retention of preservative will be calculated after correcting the volume of preservative solution to 100°F.

### 3.10 CARE OF TREATED WOOD

- A. In handling treated material, extreme care shall be used to avoid damage to the edges of the timbers or breaking through the portions penetrated by the treatment and exposing untreated wood.
- B. The use of peaveys, timber dogs, picaroons, log hooks, or other pointed tools shall be such as not to break through the treated portion of treated timber.

### 3.11 PLANT STORAGE

- A. The storage yard for seasoning shall be in the open where the air current will circulate freely; shall not be in a low humid situation if it can be avoided; shall have good drainage; and shall be kept free from vegetation and debris, especially from scrap wood already infected with decay.
- B. Treated materials shall be stored in a similar manner to untreated, but must not be piled in same area with untreated materials.
- C. Unseasoned material must be stacked separately from seasoned or partly seasoned material.

### 3.12 STACKING

- A. Sawn ties shall be stacked either 1 x 9 or 2 x 9 standard stacking method.
- B. Alternate: If necessary to retard evaporation of moisture from the ties, they may be stacked parallel on edge, using cross ties as separators.

### 3.13 BARKING

- A. Remove bark and inner skin before treatment.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

### **4.02 PAYMENT**

- A. 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 34 11 34**

**SECTION 34 11 36**  
**ELASTIC RAIL FASTENERS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section specifies the material requirements and performance criteria for Elastic Rail Fasteners to be furnished in accordance with Contract Documents or required by the Engineer.

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
1. Manual for Railway Engineering, Chapter 5, Part 9, Design Qualification Specification for Elastic Fasteners on Timber Cross Ties
- B. American Society for Testing of Materials (ASTM)
1. ASTM A123, Standard Specifications for Zinc (Hot-Dip Galvanized) Coatings on iron and Steel Products
  2. ASTM A689 - Standard Specification for Carbon and Alloy Steel Bars for Springs
  3. ASTM E112 - 10 Standard Test Methods for Determining Average Grain Size
  4. ASTM E18 - 08b Standard Test Methods for Rockwell Hardness of Metallic Materials
- C. British Standards Institute
1. BS EN 10089 - Hot rolled steels for quenched and tempered springs, grade 56SiCr7
- D. International Organization for Standardization (ISO)
1. ISO 9001 Quality Management Systems – Requirements
  2. ISO 643:2003 Steels -- Micrographic Determination of the Apparent Grain Size
- E. SCRRRA: Engineering Standards.
- F. Shepherd Fracture Grain Size Standards

### 1.03 DEFINITIONS

- A. The word "Vendor" used in this Specification shall mean the Contractor.
- B. Closure Rails – The rails between the parts of any Elastic rail fasteners layout, such as the rails between the switch and the frog in a turnout
- C. Fasteners – Joint bars, bolts, clips and spikes
- D. Shepherd Fracture Grain Size Standards:
  - 1. Shepherd Fracture Grain Size Standards were developed by B.F. Shepherd for use in conjunction with his paper titled "The P - F Characteristic of Steel," published in the Transactions of the American Society for Metals 1934, Vol. 22, Page 979.
  - 2. The set of Fracture Grain Size Standards consists of 10 fractured specimens (each 3/4" diameter) in an enclosed compact case. Each specimen is numbered consecutively from 1 (coarse grain) to 10 (fine) and are accurately spaced with equal increments of fracture differential through this range.
  - 3. Shepherd Fracture Grain Size Standards are available from MetLab Corporation, Post Office Box 1075, 4011 Hyde Park Boulevard, Niagara Falls, New York 14302-1075. Telephone (800) 828-6866.
  - 4. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 oz. of zinc per square foot of metal (average specimens) unless noted otherwise or directed by the standard.

### 1.04 SUBMITTALS

- A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the turnouts have been placed in service.
- B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.
- C. The Vendor shall submit for SCRRA's review and approval quality control and quality assurance plans and related certifications such as ISO 9001, "six sigma" or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality Elastic rail fasteners Materials included in the list of Elastic rail fasteners items as provided in the Schedule of Quantities and Prices.
- D. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing Elastic rail fasteners material to Class 1 Freight, passenger or commuter railroads.

- E. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRA's Standard Specifications Section 01 25 00, "Substitution Procedures". The specifications are available on SCRRA's website at [www.metrolinktrains.com](http://www.metrolinktrains.com).
- F. Qualifying Tests: The Vendor or supplier must submit the results of the following initial qualifying tests for equivalent fasteners:
  - 1. AREMA Manual for Railway Engineering, Chapter 30, Part 2.6:
    - a. Test 5A – Fastener Uplift,
    - b. Test 5B – Fastener Longitudinal Restraint,
    - c. Test 5C – Fastener Repeated Load,
    - d. Test 5D – Fastener Lateral Load Restraint,
    - e. Test 5E – Fastener Assembly Rotation.
- G. Fatigue Tests:
  - 1. The Vendor or supplier must submit the results of the fatigue tests used to determine final acceptance of the clips from each heat of steel.
- H. Shepherd Fracture Grain Size Analysis: The Vendor must submit the results of the Shepherd Fracture Grain Size analysis.
- I. Samples:
  - 1. The Vendor or supplier must submit samples of the raw material used in the production of the clips for independent verification, by SCRRA, of the chemical, physical, and mechanical properties steel used in the production of the clips.
  - 2. The Vendor or supplier must submit, upon request by SCRRA, up to 20 samples of finished clips without charge for fatigue testing by SCRRA
- J. Mill Test Reports:
  - 1. The Vendor or supplier must submit mill test reports for each heat of steel used in the manufacture of the clips furnished on a given order.

#### **1.05 QUALITY ASSURANCE**

- A. Vendor's Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program.
- B. Manufacture must be performed by companies certified to ISO 9001: 2000. Certification must be held by the plant producing the clips. Certification of a distributor for a manufacturer is not sufficient to satisfy this requirement.

- C. Materials or partially or fully assembled products not meeting the specifications shall be rejected. Elastic rail fasteners materials delivered to SCRRA shall be either promptly modified to meet specifications or removed from SCRRA's delivery and storage locations within 30 calendar days.
- D. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.
- E. Final fatigue testing of the clips may be performed in the facility of a manufacturer, or a distributor, or an independent testing laboratory. However, all fatigue testing must be performed within the coterminous United States and subject to witness by representatives of SCRRA. Notice of testing must be provided to SCRRA a minimum of three weeks prior to the tests. A representative of SCRRA will select the samples to be tested.

#### **1.06 DELIVERY, STORAGE AND HANDLING**

- A. The Vendor shall load, transport, and handle the material in a manner which will prevent damage to the material.
- B. The material will be supplied to the SCRRA in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRA. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.

### **PART 2 - PRODUCTS**

#### **2.01 DESIGN**

- A. Clips must be Pandrol® brand type e-2055 (e-2056 for left hand application) elastic rail clips or an equivalent in shape, size, function, and performance as generally described in United States Patent No. 4,413,777, and as shown on SCRRA ES2361 and ES2362. The equivalence of any alternative design, including the chemical and physical characteristics of the material, must be established through qualification by successful performance the tests described in AREMA Manual for Railway Engineering, Chapter 30, Part 2.6, Test 5A – Fastener Uplift, Test 5B – Fastener Longitudinal Restraint, Test 5C – Fastener Repeated Load, Test 5D – Fastener Lateral Load Restraint, and Test 5E – Fastener Assembly Rotation. For the purpose of conducting Test 5A – Fastener Uplift, the load “P” must be not less than 5500 pounds for each pair of fasteners.
- B. 'Pandrol' Brand Rail Clips form part of a 'Pandrol' Brand Rail Fastening System and hold the rail to the tie, baseplate or other track support.



- C. A new qualification test must be performed for each change in dimension or shape of the clip, or a change in the chemical, physical, and mechanical properties of the raw material used in the manufacture of the clip.
- D. In lieu of performing the acceptance tests SCRRA may, at its sole discretion, may accept a clip offered as an equivalent to the specified clip upon evidence of satisfactory in-track performance for 10 years or more on a North American main line carrying 40 MGT or more each year.
- E. The supplier shall have a minimum of five years' experience in supplying rail clips and other track materials.

## **2.02 PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES**

- A. The raw material must be a fine-grained chromium allow spring steel with a composition closely approximating SAE/AISI Grade 5160, or ASTM A689, or BS EN 10089. Modifications to the basic alloy by the Vendor of the steel are required to achieve the physical, mechanical, and performance requirements of this specification.
- B. Shepherd fracture grain size of the raw material must be seven (7) or greater.
- C. Finished clips must possess a Rockwell C surface hardness not less than 44 or more than 48 when tested in accordance with ASTM E18.
- D. All pair of finished rail clips must produce a minimum resistance load of 5500 pounds before separation of the rail from the rail seat when tested in accordance with AREMA Manual for Railway Engineering, Chapter 30, Part 2.6, Test 5A Fastener Uplift.

## **2.03 MANUFACTURE**

- A. Rail clips must be formed from a round bar stock made from a fine-grained chromium allow spring steel. The steel must be quenched and tempered during manufacture to achieve the physical and mechanical characteristics specified, and meet the requirements of the qualification tests.

## **2.04 PERFORMANCE REQUIREMENTS**

- A. Five clips produced from each heat of raw steel material must be tested after manufacture for fatigue failure. In performing the test, a single clip must be fixed in the test machine and a 2750-pound load applied at the toe of the clip. The clip must then be raised 1mm above the neutral (2750 pound load point) and relaxed to a point 1 mm below the neutral (2750 pound load point) through three million (3,000,000) cycles (one cycle = neutral to raised position to lowered position to neutral position).
  - 1. Rail fastening system shall be resilient, thread-less and adjustable in three steps without dismantling the fastener. The three steps shall be:
    - a. Retracted: Permits installation or removal of rail intermediate

- b. Permits longitudinal rail movement clamped
  - c. Provides full rail clamping force.
- B. The Vendor may use a test procedure similar to that described in Chapter 30, Part 2.6, Test 5A, of the AREMA Manual for Railway Engineering, or the Vendor may the test described in Appendix I of Australian Standard 1085.19, or the Vendor may use another test procedure provided that the clip moves through a distance of 2mm, under a load of 2750 pounds at the mid-point of the range of flexure.
- C. From the 5 clips selected, if two clips in a row break, all clips manufactured from the heat of steel tested must be rejected. If two clips in a row pass, all clips from the heat of steel tested, may be accepted.
- D. A failure is recorded when a tested clip exhibits a loss of elasticity, breaks, or the neutral position load drops below 2750 pounds during the test.
- E. Table below lists the possible test combinations and the action to be taken:

**Table**

Test Number and Results					Action
1	2	3	4	5	
Pass	Pass				Heat of Steel Passes All Clips from Heat Accepted No Further Tests Required
Pass	Fail	Pass	Pass		Heat of Steel Passes All Clips from Heat Accepted No Further Tests Required
Pass	Fail	Fail			Heat Fails All Clips from Heat Rejected No Further tests permitted
Pass	Fail	Pass	Fail	Fail	Heat Fails All Clips from Heat Rejected No Further tests permitted
Pass	Fail	Pass	Fail	Pass	Heat Fails All Clips from Heat Rejected No Further tests permitted
Fail	Fail				Heat Fails All Clips from Heat Rejected No Further tests permitted
Fail	Pass	Pass			Heat of Steel Passes All Clips from Heat Accepted No Further Tests Required
Fail	Pass	Fail	Pass	Pass	Heat of Steel Passes All Clips from Heat Accepted No Further Tests Required
Fail	Pass	Fail	Pass	Fail	Heat Fails All Clips from Heat Rejected No Further tests permitted

- F. At the conclusion of the fatigue test above, the pair of clips that have passed the fatigue test must prevent separation of the rail from the rail seat when a minimum uplift load “P” of 5500 pounds in accordance with AREMA Manual for Railway Engineering, Chapter 30, Part 2.6, Test 5A - Fastener Uplift.
- G. The clips must not break when applied or removed with a 8 lb to 12 lb sledge hammer provided that the clips are not over-driven.

**2.05 TOLERANCES**

- A. The clips shall conform to the dimensions on SCRRA drawing and shall fit the relevant standard 'Pandrol' inspection gauges and/or direct measuring fixture.
- B. Alternatively, a Vendor may provide its standard dimensional tolerances and the means used to measure each clip for conformance to the standard to SCRRA for review approval.

**2.06 INSPECTION**

- A. All clips must be inspected for visual defects, incomplete formation, damage, or dimensional non-conformance.

**2.07 NUMBER OF TESTS AND RETESTS**

- A. A minimum of five clips from each heat of steel used for Vendor of the clips must be tested. SCRRA may, at its expense, select additional clips from any order and submit them to the fatigue test described in this specification. SCRRA will provide the Vendor or supplier a minimum notice of three weeks in advance of the date on which the test will be performed. The Vendor or supplier may, at its expense, send a representative to witness the test.
- B. The Vendor must replace without charge any unused portion of an order that does not pass the fatigue test administered by SCRRA with clips that conform to the requirements of this specification.

**2.08 WORKMANSHIP, FINISH, AND APPEARANCE**

- A. The clips must be free from burrs which may be considered harmful when handled or affect efficient assembly of the clip. Marks caused by the forming tools shall be smooth and free from sharp indentations.
- B. All clips must be Hot Dipped Galvanized in accordance with ASTM A123.

**2.09 PRODUCT MARKING**

- A. Each clip must be stamped with a code indicating the date of manufacture, the manufacturer, and the plant in which the clips have been made. A mark indicating the heat of steel used must also be included if the above information is not sufficient to trace the clip to a specific heat of steel.

**2.10 PACKAGING AND PACKAGE MARKING**

- A. Clips must be packaged in sacks containing 30 fasteners (approximately 50 lbs) unless otherwise specified or approved by SCRRA.

**2.11 SOURCE QUALITY CONTROL**

- A. Vendor must be performed by companies certified to ISO 9001: 2000. Certification must be held by the plant producing the clips. Certification of a distributor for a Vendor is not sufficient to satisfy this requirement.

- B. Final fatigue testing of the clips may be performed in the facility of a Vendor, or a distributor, or an independent testing laboratory. However, all fatigue testing must be performed within the coterminous United States and subject to witness by representatives of SCRRA. Notice of testing must be provided to SCRRA a minimum of three weeks prior to the tests. A representative of SCRRA will select the samples to be tested.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. Comply with the SCRRA Engineering Standards Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

#### **3.02 SCHEDULE**

- A. The Vendor providing the materials shall contact SCRRA's Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

### **PART 4 - MEASUREMENT AND PAYMENT**

#### **4.01 MEASUREMENT**

- A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

#### **4.02 PAYMENT**

- A. 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 34 11 36**

## SECTION 34 11 40

### PRECAST CONCRETE GRADE CROSSING PANELS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. This Section specifies the material requirements and performance criteria for the Precast Concrete Grade Crossing Panels to be furnished in accordance with Contract Documents or required by the Engineer.

##### 1.02 REFERENCES

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering
  - 2. Specifications for Special Trackwork
- B. American Welding Society (AWS):
  - 1. AWS B2.1: Standards for Welding Procedures and Performance Qualifications
  - 2. AWS D1.1: Structural Welding Code
- C. American Society for Testing of Materials (ASTM)
  - 1. A36: Standard Specifications for Carbon Structural Steel
  - 2. A123: Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products
  - 3. A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  - 4. C666: Standard test Method for Resistance of Concrete to Rapid Freezing and Thawing
  - 5. C1260: Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
  - 6. D257: Standard Test Methods for DC Resistance of Conductance of Insulating Materials
  - 7. D395: Standard Test Methods for Rubber Property/Compression Test
  - 8. D412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension

9. D573: Standard Test Methods for Rubber Deterioration in an Air Oven
  10. D624: Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
  11. D2137: Standard test Methods for Rubber Property- Brittleness Points of Flexible Polymers and Coated Fabrics
  12. D2240: Standard Test Methods for Rubber Property-Durometer Hardness
  13. D2628: Standard Specifications for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- D. Association of American Railroads (AAR)
1. M-1003: Manual, Specifications for Quality Assurance
- E. International Organization for Standardization (ISO)
1. 9000: An International Consensus on Good Quality Management Practices
- F. Prestressed Concrete Institute (PCI)
1. MNL115: Fundamental of Prestressed Concrete Design
  2. MNL124: Design and Typical Details of Connection for precast and Prestressed Concrete
  3. MNL138: PCI Connections Manual for Precast and Prestressed Concrete Construction
- G. SCRRRA: Engineering Standards, especially ES2402.

### 1.03 DEFINITIONS

- A. The word "Vendor" used in this Specification shall mean the Contractor.
- B. Field Side – End of tie plate designed to be located on the opposite side of the rail from the centerline of track
- C. Gage Side – End of tie plate designed to be located closest to the centerline of track
- D. OTM – A general term referring to all miscellaneous materials other than rail and ties
- E. Shunt – A connection between two points in an electric circuit that forms an alternative path for a portion of the current

**1.04 SUBMITTALS**

- A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the precast concrete grade crossing panels have been placed in service.
- B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.
- C. The Vendor shall submit for SCRRA's review and approval quality control and quality assurance plans and related certifications such as ISO 9001, "six sigma" or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality precast concrete grade crossing panels included in the Schedule of Quantities and Prices.
- D. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing precast concrete grade crossing panels material to Class 1 Freight, passenger or commuter railroads.
- E. The Vendor shall include installation instructions.
- F. Submit Certificates of Compliance for all precast concrete grade crossing panels. Include material qualification test reports for materials, components, and assemblies.
- G. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRA's Standard Specifications Section 01 25 00, "Substitution Procedures". The specifications are available on SCRRA's website at [www.metrolinktrains.com](http://www.metrolinktrains.com).

**1.05 QUALITY ASSURANCE**

- A. Vendor's Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program.
- B. Materials or partially or fully assembled products not meeting the specifications shall be rejected. Precast concrete grade crossing panels delivered to SCRRA shall be either promptly modified to meet specifications or removed from SCRRA's delivery and storage locations within 30 calendar days.
- C. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.

**1.06 DELIVERY, STORAGE AND HANDLING**

- A. The Vendor shall load, transport, and handle the material in a manner which will prevent damage to the material.

- B. The material will be supplied to the SCRRA in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRA release document. The material when purchased is to be delivered to the Southern California area at a place designated by the SCRRA. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.

### **1.07 WARRANTY**

- A. The Vendor shall warranty the precast concrete grade crossing panels for a minimum ten years against defects in materials and workmanship.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. Precast concrete grade crossing panels shall be new and conform to SCRRA Engineering Standards ES4201.
- B. Precast concrete grade crossing panels ordered to the Engineering Standards shall be produced in conformance to these specifications.

### **2.02 CONCRETE PANELS**

- A. Precast concrete grade crossing panels shall be lag-down heavy duty panels.
- B. Precast concrete grade crossing panels shall be designed for use on 10 feet wood track ties and ballast track.
- C. Precast concrete grade crossing panels shall have flangeways not less than 2½" in width and be electrically isolated to prevent shunt currents.
- D. Precast concrete grade crossing panels shall be sized such that when installed, the top of the panels is at the top of rail elevation.
- E. Panels shall be of the type which fastens to the timber ties utilizing a lagging screw system which fastens from the top down. The lagging screws shall be mechanically galvanized with zinc coating in a room temperature process, without electricity and without heat.
- F. Rubber flangeway filler shall be designed to match the precast concrete crossing panels and rail fastening system.
- G. Grade crossing surface systems, including any flangeway (gage and field side) filler material components, must be electrically non-conductive so as not to interfere with train control or crossing signals.



- H. Each gage panel shall incorporate a 3" UHMW shunt break to assure electrical isolation. End angle for gage panels shall have 3" minimum gap to improve shunt resistance.
- I. Concrete Crossing Panels shall be by Omega Industries or approved equal for use on SCRRA.

### **2.03 CONCRETE**

- A. Concrete compressive strength shall be minimum 6000 psi. The compressive strength shall be 2500 psi before panel is removed from forms and 5,000 psi at 21 days.
- B. Minimum cement content shall be seven sacks per cubic yards.
- C. Maximum water/cement ration shall be 0.44. Slump shall not exceed three inches.
- D. Concrete sealant shall be used to prevent cracks and ion migration. Sealant shall be applied to fresh concrete as an aid in curing, hardening, water proofing, acid proofing and oil proofing each panel.

### **2.04 STRUCTURAL STEEL**

- A. Reinforcing steel shall be grade 60.
- B. Steel angles shall be ASTM grade 36. The exposed steel shall receive one primer coat.

### **2.05 RUBBER FLANGWAY FILLER**

- A. Rubber flangeway filler shall be permanently attached to the concrete panels.
- B. Rubber flangeway filler shall meet the following:
  - 1. Tensile strength – 850 psi
  - 2. Ultimate elongation – 400% minimum
  - 3. Tear strength at 25 degree Celsius – 150 pli minimum
  - 4. Hardness – 75
  - 5. Compression set 100 degrees Celsius for 70 hours
  - 6. Accelerated aging test – 70 hours
  - 7. Ozone resistance test – 5- PPHM for 96 hours
  - 8. Electric resistance – 10 mega ohms minimum

- C. The pre-attached flangeway filler shall allow for the removal of panels for maintenance without damaging the flangeway filler or any other components designed to hold the panel together.

## **2.06 FINISHES**

- A. All recess and minor concrete spalls are to be filled and finished to the panel dimensions using the proper bonding agent and repair material. Surface of the repaired area is to match the color and texture of the surrounding area.
- B. The driving surface is to have a light broom finish or as approved by SCRRA. The addition of water to the concrete surface finish during casting is not permitted.

## **2.07 MARKING**

- A. Each precast concrete grade crossing panel shall be marked with concrete imprint for size of rail, weight of panel, Manufacturer's ID, month/day/year of manufacture and crossing type. End of each panel will be stenciled painted with size of rail, weight of panel and crossing type.

## **2.08 SOURCE QUALITY CONTROL**

- A. During precast concrete grade crossing panel fabrication, perform the tests and inspections specified in these Specifications.
- B. Vendor shall submit (via an independent testing laboratory to SCRRA), the freeze/thaw, mortar bar method and total alkali burden (0.06%) tests on the mix design.
- C. A representative sample of panels shall be checked for bottom flatness.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Comply with the SCRRA Engineering Standards Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

### **3.02 SCHEDULE**

- A. The Vendor providing the materials shall contact SCRRA's Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

**PART 4 - MEASUREMENT AND PAYMENT**

**4.01 MEASUREMENT**

- A. Work of this Section is considered incidental to work associated with project item in Section 34 71 50, Highway-Rail Grade Crossings and no separate measurement and payment will be made to the Contractor for Work of this Section.

**4.02 PAYMENT**

- A. 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 34 11 40**

**SECTION 34 42 00**  
**GENERAL SIGNAL REQUIREMENTS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. The work in this Section includes, but is not limited to, general procedures, requirements, and incidental to the planning, manufacturing, installation, removal, relocation, modification, testing, placing in service, and documentation of as-built conditions of the various signal systems.
- B. General:
  - 1. Provisions of this Section apply to all Sections of Division 34, Transportation, Subdivision 34 42, Railroad Signals.
  - 2. Modify existing equipment and material as shown on the Contract Plans to interface with the existing and proposed signal system.
- C. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 01 14 19 – Coordination with Utilities
  - 2. Section 01 29 73 – Schedule of Values
  - 3. Section 01 33 00 – Submittal Procedures
  - 4. Section 01 35 15 – Maintenance and Protection of Railroad Traffic
  - 5. Section 01 43 23 – Contractor Qualifications and Requirements
  - 6. Section 01 56 37 – Worksite Security Requirements
  - 7. Section 01 78 39 – Project Record Documents
  - 8. Section 09 90 00 – Painting and Coatings
  - 9. Section 09 96 23 – Graffiti-Resistant Coating
  - 10. Section 31 20 00 - Earthwork

**1.02 REFERENCES**

- A. Electrical equipment, unless specifically excluded herein, shall conform to the standards of the National Electrical Manufacturers Association (NEMA), The Underwriters' Laboratories Inc., (UL), the Electrical Testing Laboratories (ETL), the National Electrical Testing Association, Inc. (NETA), or the Electronic Industries Association (EIA), wherever applicable. Unless specifically excluded herein, materials and workmanship shall conform to the requirements of the

National Electrical Code; California Administrative Code, Title 8, Chapter 4, Subchapter 5, Electrical Safety Orders; SCRRA Design Criteria Manual, SCRRA Engineering Standards, and any applicable local ordinances.

B. The following General Orders (G.O.) or the most current General Orders of the State of California Public Utilities Commission (CPUC) shall apply:

1. G.O. 26D Clearances on Railroads and Street Railroads as to Side and Overhead Structures, Parallel Tracks, and Crossings
2. G.O. 52: Construction and Operation of Power and Communication Lines for the Prevention or Mitigation of Inductive Interference
3. G.O. 75D Regulations Governing Standards for Warning Devices for At-Grade Highway-Rail Crossings
4. G.O. 88B Rules for Altering Public Highway-Rail Crossings
5. G.O. 118A Construction, Reconstruction and Maintenance of Walkways and Control, of Vegetation Adjacent to Railroad Tracks
6. G.O. 128 Construction of Underground Electric Supply and Communication Systems

C. The following parts of the Code of Federal Regulations, Title 49, Transportation, shall apply:

1. Part 212 State Safety Participation Regulations
2. Part 219 Control of Alcohol and Drug Use
3. Part 218 Railroad Operating Practices
4. Part 228 Hours of Service of Railroad Employees
5. Part 234 Grade Crossing Safety
6. Part 235 Instructions Governing Application for Approval of a Discontinuance or Material Modification of a Signal System or Relief from the Requirements of Part 236
7. Part 236 Rules, Standards, and Instructions for Railroad Signal System
8. Be responsible for adherence to all the above rules and reporting requirements, including those regulations which require pre-employment drug testing and random drug testing of employees engaged in the installation and testing of signal facilities, and the reporting and tracking of employees injured in the performance of work on a railroad.

- D. California Manual on Uniform Traffic Control Devices (CA MUTCD), Part VIII, Traffic Control for Railroad and Light Rail Transit Grade Crossings, shall apply.
- E. In addition to the regulations and code requirements specified in this Section, materials and equipment for the signaling systems shall conform to the standards and recommendations of the Communication and Signals Manual of Recommended Practices of the American Railway Engineering and Maintenance of Way Association (AREMA), hereinafter referred to as the AREMA C&S Manual, except that where the Manual uses the word “should”, it shall be substituted with the word “shall”.
- F. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals (C&S) Manual, Part 1.5.10, Recommended Instructions for Painting and Protective Coatings.

### 1.03 SYSTEM DESCRIPTION

- A. Provide all materials and installation services required for a complete working signal system, as described herein, and as shown on the Contract Plans, including any equipment not designated as being relocated or designated as Owner-furnished or in these specifications.
- B. All materials and equipment for installation and for interconnection of the various signaling systems shall be fabricated, furnished, and installed as indicated on the Contract Plans and specified herein.
- C. The Contract Plans represent a final design utilizing systems, components, and materials that meet the Project Specifications. Contractor may provide equivalent systems, components, and materials subject to the approval of the Engineer. If equivalent systems, components and materials are provided, the Contractor shall provide an alternate detailed final design as specified herein under Design Submittals.
- D. Provide systems that are compliant with applicable rules and regulations of CFR 49, parts 234 and 236, and CPUC GO 75D. Refer to Design Submittals herein for Contractor’s responsibility to indicate any corrections or modifications to the Contract Plan’s final design that the Contractor may determine are required to conform to these rules and regulations.
- E. Be present at all design meetings held with the Engineer by a signal engineer qualified in the application and installation of the signaling equipment the Contractor proposes for use on this project.
- F. No circuit is considered to have met the requirement of these Specifications for function and safety until it has been properly tested and verified in the field. Any circuit changes made to meet the functional and safety requirements of these Specifications shall be considered as included as part of the work.

- G. Provide continuous train control and highway grade crossing warning during all phases of rail construction. The work of the Contractor must not present a delay to train operations, cause an unsafe signaling condition, or reduce the effectiveness or quality of the existing or new grade crossing warning systems. The Contractor shall submit, for approval by the Resident Engineer, its proposed plan for providing alternate methods of crossing warning whenever the existing automatic crossing warning devices are deactivated, altered, or modified to accommodate construction work. Alternate methods shall conform to CFR 49, Part 234, and all local ordinances.
1. Refer to Design Submittals herein for requirements for submittal of plans for providing wayside signaling and highway crossing warning systems protection during the work and plans for point protection and fouling when crossovers are installed or removed. Alternate methods shall conform to CFR 49, Part 234, Part 236 and all local ordinances.
- H. Provide rail bonding for all new, temporary and relocated turnouts as shown on the Contract Plans or as required by the Engineer. Provide rail bonding, as necessary, to maintain existing systems during construction of all projects related work, including the work of other disciplines.
- I. Protect existing signal cabling and, where necessary, relocate existing cabling to prevent damage during track installation and surfacing. If the Contractor damages existing cabling, the Contractor shall be responsible for all repairs, testing and replacement, if necessary, to existing cabling. Provide all new signals, new foundations, new cabling, and other new equipment as shown on Contract Plans. The Contractor shall remove and reuse existing signaling equipment as indicated on the Contract Plans and in these Specifications.
- J. Refer to Section 01 78 39, Project Record Documents, and additional requirements specified herein. Record the final As-Built conditions of the signal systems for each system.
- K. Perform and document all tests and inspections in accordance with CFR 49 regulations, the AREMA C&S Manual, the Metrolink Signal Maintenance Manual, and these Specifications.
- L. Refer to Section 01 43 23, Contractor Qualifications and Requirements, and additional requirements specified herein. Provide at least one qualified signal person to accompany any on-track equipment, and remove, relocate, or disconnect and reconnect any signal equipment that could be damaged by on-track equipment.
- M. Coordinate installation, inspection, and testing of new Owner-furnished material with the Engineer. Notify the Engineer in writing 30 days prior to any installation, inspection, and testing as part of this coordination.
- N. Perform acceptance testing and commissioning of the signal system as a normal part of the work.

- O. Contractor furnished software and components shall be new, manufacturer certified, and the latest SCRRRA approved version.
- P. Remove, salvage, retire, relocate, furnish, and install project related devices as indicated on the Contract Plans, as described within the Project Specifications, and as required to complete the Work.
  - 1. Before retiring a grade crossing or signal location, the Contractor shall coordinate with the Resident Engineer to ensure all stakeholders have been properly notified. These stakeholders include, but are not limited to, City officials, Metrolink Operations, Metrolink Configuration Management and related freight carriers. The Contractor shall take all temporary measures necessary to ensure the removal does not interfere with the safe operation of the railroad, railroad employees, and the public.
- Q. Refer to Section 31 20 00, Earthwork, for provisions for excavation and requirements for shoring of excavation as specified in Section 31 50 00, Excavation Support.
- R. Refer to Division 31, Earthwork and 01 14 49, Coordination with Utilities, for requirements in locating and protecting existing utilities. Details of signal cable runs, conduit runs, and pull box installations including number, size, and type of cable are shown in the Contract Plans. Conduit runs and pull box locations, as shown, are the preferred locations. In case of conflict between the systems design plans and other Contract Plans, the systems design plans take precedence as to detail, and in the event of conflict as to placement of equipment, the Engineer will determine the correct placement.
  - 1. Make any minor deviations in location, minor meaning within 10 feet of the location as shown on the Contract Plans, as part of the Work. Deviations exceeding 10 feet may be subject to the change provisions of General Conditions.
- S. All underground signal cables shall be in conduit, except for the final wire connections made to the track.
- T. Any components or equipment proposed by the Contractor as an equal to those specified, which are not currently in use on the Metrolink system or that do not have spare maintenance parts in SCRRRA stocks, will require that the Contractor furnish sufficient spare components equal to 10% of the quantity order or a minimum of two (2) additional units, whichever is greater. The Contractor shall also arrange for manufacturer provided training for all Metrolink maintenance personnel. Spares and training are to be furnished by the Contractor at no additional expense to SCRRRA.
- U. Provide construction signal support and coordination of all work with other disciplines including, but not limited to, track installation and removal, bridge construction or reconstruction, rail and track renewal within crossings, installation or change of track switches, clearing and grubbing. Contractor shall coordinate all work with other disciplines that may affect the safe operation of existing crossings and track circuits to prevent train delays or inconvenience to the public.



#### 1.04 FAIL-SAFE DESIGN REQUIREMENTS

- A. As used in these Specifications, the fail-safe principle shall mean that whenever an equipment failure, human error or failure to act, or adverse environmental condition affects the specified operation of a system involved with the safety of life or property, that system shall revert to a state known to be safe.
- B. Failure of a circuit or equipment that results in an indication of a dangerous or restrictive condition, whether there is in fact actual danger, shall have met the fail-safe requirements. Conversely, a failure that results in an indication of safe or nonrestrictive condition when, in fact, a dangerous condition may exist shall not have met the fail-safe requirements.
- C. Vital applications, such as detector locking of switches, shall be based on the following principles that permit the attainment of fail-safe operation in all known or discovered failure modes:
  - 1. Closed Loops: Fail-safe circuits shall employ the closed loop principle and shall protect against open circuits, shorts, or any combination thereof.
  - 2. Vital Relays: Relays used in vital circuits.
  - 3. Vital Circuits: All line circuits, which energize a vital relay, shall be two-wire, double-break circuits and shall be energized from an ungrounded direct current (dc) power supply.
  - 4. Grounds: Components or wires becoming grounded shall not cause an unsafe condition.
  - 5. Spurious Oscillations: Any amplifier, generator, or device element, active or passive, breaking into spurious oscillations shall not cause an unsafe condition.
  - 6. Filters: Filters used in fail-safe circuits shall be designed to prevent undesired signals from appearing at the filter output at levels which could cause an unsafe condition.
- D. Equipment failures and conditions which shall be considered in producing a fail-safe design shall include the following, at minimum:
  - 1. Relays (non-vital): Open coil, fused contacts, high contact resistance, shorted coil, armature sticking, contacts sticking, or broken spring.
  - 2. Relay (vital as defined by the AREMA C&S Manual): Open coil, shorted coil, or high contact resistance.
  - 3. Transformers: Open primary, open secondary, shorted turns, primary-to-secondary shorts, or combinations thereof.
  - 4. Capacitors: Short, open, or leakage.

5. Resistors: Increase or decrease in resistance.
  6. Transistors: Short, open leakage, or loss of Beta.
  7. Diodes: Short, open, or reverse leakage.
  8. Coils: Open or shorted turns.
  9. Loss or degradation of power sources.
  10. Appearance of abnormal signal levels, electrical noise levels, frequencies, and delays.
  11. Effects of electrical interference.
  12. Absent or abnormal input signals.
  13. Opens or shorts in internal circuitry at inputs and at outputs.
  14. Mechanical vibration or shock.
  15. Drift or instability of amplifiers, receivers, transmitters, oscillators, switching circuits, and power supplies.
  16. Deterioration of contacts, connectors, terminals, solder connections, printed circuits, circuit adjusting devices, and mechanical devices.
- E. Fail-safe equipment proposed for vital signaling applications used on the Metrolink system, shall have been proven with a minimum of five (5) years of successful rail service operation in the United States of America. The successful rail operation shall have been performed on a Class 1 Freight Railroad or major commuter rail system similar to Metrolink.

#### **1.06 ENVIRONMENTAL PARAMETERS FOR EQUIPMENT**

- A. Contractor provided material and equipment shall be fully operable with no impairment resulting from the effect of the environment throughout the range of values indicated below. The general operating environment shall be considered to be in salty atmosphere and in generally sunny weather.
- B. Ambient outdoor temperature range: From minus 40 degrees F (minus 40 degrees C) to plus 160 degrees F (70 degrees C).
- C. Relative humidity range: From zero to 100 percent.
- D. Maximum rainfall: 4 inches in 24 hours and 1.5 inches in 1 hour.
- E. Maximum wind velocity: 100 miles per hour.
- F. Seismic Zone Location of Work Site: Seismic Zone 4 as defined in the Uniform Building Code.

- G. Isokeraunic Level: Five per year.

### 1.07 SUBMITTALS

- A. Do not begin any work without the prior submittal to and approval by the Resident Engineer of the relevant personnel, plans and procedures.
- B. Submit résumés of the proposed Signal Engineer(s) and Signal Manager(s) within 14 calendar days after receiving Notice to Proceed.
- C. Submit to the Engineer for approval, proposed design changes, plans, test and inspection procedures, data sheets of proposed material, installation details, Shop Drawings, mechanical Drawings, proofs of compliance with applicable standards, and any other pertinent data required to fully demonstrate the Contractor's proposed plan for the manufacture, installation, testing, and maintenance of the various signaling systems. The Contractor shall provide submittals within 30 calendar days after receiving Notice to Proceed.
- D. Submit to the Resident Engineer 4 sets of application, installation, operating, and maintenance manuals of all new equipment and systems utilized under this Contract a minimum of 30 calendar days prior to placing any system in service.
- E. Submit a detailed test plan for all systems a minimum of 60 days in advance of placing any system in service. These test plans shall reflect the latest revisions and changes approved by the Resident Engineer and made because of field checks and conditions. The Contractor shall not proceed with the cutover or in-service testing until the Engineer approves the test plans. Plans shall include, but are not limited to:
  - 1. Proposed plan for providing alternate methods of wayside signaling and highway crossing warning systems protection when signal components are relocated, deactivated, altered, or modified to accommodate construction work.
  - 2. Plan for point protection and fouling when crossover or turnouts are installed or removed.
- F. Prepare and submit a Signaling Construction Phasing Plan for each location where a signal system is to be modified, installed, or removed. The Plan, as a minimum, shall contain the following:
  - 1. A narrative description of the work to be undertaken at the designated location.
  - 2. A step-by-step phasing of work description which identifies those steps during which the existing system will be disabled, and a description of what steps will be taken to assure that the signal system will be tested and returned to full operation without causing a delay to any train movement.

3. An estimate of time to complete the critical steps in the phasing.
- G. Manufacturers' warranties and guarantees furnished for materials used in the work, instruction sheets, and part lists supplied with materials shall be delivered to the Resident Engineer prior to acceptance of the project. All equipment, material warranties, and guarantees shall cover parts and labor for two years from the date of final acceptance.
  - H. After a location is placed in service and prior to final acceptance of the project, the Contractor shall submit as-built documentation as follows:
    1. Submit four copies of all as-built circuit plans and documents to the Resident Engineer within 3 business days.
    2. Final application logic documentation within 3 business days.
    3. Civil Drawings which show the physical location of all signal apparatus and conduits, both along the tracks and perpendicular to it, and heights of all signal structures within 60 calendar days.
  - I. Resident Engineer or his/her representative may inspect the Contractor's furnished materials and work procedures during all phases of construction. Materials and procedures that fail to meet the requirements of these specifications, or regulations, shall not be installed or placed in operation.
  - J. Ensure that equipment used in the testing of wayside signal and grade crossing warning systems and components shall be properly calibrated. Test meters and other test apparatus shall have been inspected by a recognized facility that performs calibrations a minimum of 6 months prior to performing required tests. A sticker, or other documentation, must be made available for inspection at the request of the Resident Engineer.

#### **1.08 DELIVERABLES**

- A. Submit manufacturers' warranties, instruction sheets, and part lists supplied with materials to the Resident Engineer prior to final acceptance.
- B. Operation and Maintenance Data: Refer to Section 01 33 00, Submittal Procedures, for Operations and Maintenance Data Manual requirements. A minimum of 30 days prior to placing any system in-service, submit to the Resident Engineer 10 sets of application, installation, operating, and maintenance manuals of all new equipment and systems utilized under this Contract which are provided by the Contractor. Include complete material ordering reference numbers for each type of product.

#### **1.09 QUALIFICATIONS AND DUTIES OF SIGNALING PERSONNEL**

- A. Refer to Section 01 43 23, Contractor Qualifications and Requirements. Key employees of the Contractor engaged in the final adjustment and testing of the various signaling systems shall be qualified and have had experience on an

operating railroad in the type and level of signal installation and testing work as required herein.

- B. Signal Engineer as used herein shall be understood to mean Contractor's railroad signal engineer or engineers approved by the Engineer. Signal Manager as used herein shall be understood to mean Contractor's railroad signal manager or managers approved by the Engineer. Signal Electrician, as used herein, shall be understood to mean Contractor's electrician(s) used to perform wiring and installation of railroad signal and grade crossing warning system circuits, component, and control equipment and devices including their primary and backup power supply systems.
- C. Signal construction and installation personnel shall work under the authority of the Signal Engineer. The Contractor's signaling construction forces shall work under the authority of a Signal Engineer.
  - 1. Signal Engineer shall plan, direct, and oversee the adjustment, installation, and testing of signal related work and shall coordinate signal work with related track construction work and roadway work.
  - 2. Signal Engineer shall be responsible for all work under his charge and must have the authority to remove any personnel from the project who are not performing the work in a satisfactory manner. The Signal Engineer shall obtain, review, and maintain documentation of the required minimum experience, a copy of the Electrician's license(s), and a record of wage rate paid for each Signal Electrician that performs Signal or Crossing Warning System work prior to that Electrician starting any Signal related work. This documentation shall be always available for review by the Resident Engineer upon request.
  - 3. Signal Engineer shall be on site whenever signal related work or track construction work is in progress in the vicinity of existing wayside signaling equipment, highway grade crossings, and/or cabling.
- D. The Signal Managers shall report to and work under the direct authority of the Signal Engineer and shall supervise and direct the work of all signal construction and installation personnel.
- E. Signal Engineer shall direct and organize the performance of all tests on signaling equipment and systems, under direction of the Engineer, prior to releasing the systems for service. The Signal Engineer shall be responsible to ensure that all applicable test documentation other than that documentation provided by the Engineer, is completed prior to, or immediately after, in-service testing is completed.
- F. The proposed Signal Engineer shall demonstrate experience in the philosophy, application, installation, and testing requirements of the various signaling systems. The proposed Signal Engineer shall have a minimum of 10 years signal supervisory or management related experience on a Class I railroad, or commuter railroad comparable to SCRRRA. The proposed Signal Engineer shall also demonstrate knowledge of the governing General Code of Operating Rules,

including CPUC and FRA regulations and procedures. This demonstration shall be by interview of the proposed Signal Engineer by the Engineer prior to commencement of any work that may affect the signal system. The work of this project includes working within constrained work windows on a live railroad consisting of freight trains, inter-city passenger trains, and Metrolink commuter trains. Candidate shall have a similar level of experience. The Engineer's decision concerning the candidate's qualifications will be final. Begin no signaling related work prior to obtaining Engineer's approval of the Signal Engineer. In addition, obtain the Resident Engineer's approval of each Signal Engineer prior to beginning any work that may affect the signal system. Obtain approval of additional Signal Engineers as required depending upon the level and type of work being performed.

- G. The proposed Signal Managers shall demonstrate experience in the philosophy, application, installation, and testing requirements of the various signaling systems. The proposed Signal Managers shall have a minimum of 3 years signal supervisory or management related experience on a Class I railroad or commuter railroad comparable to SCRRA. The proposed Signal Managers shall also demonstrate knowledge of the governing General Code of Operating Rules, including CPUC and FRA regulations and procedures. This demonstration shall be by interview of the proposed Railroad Signal Managers by the Engineer prior to commencement of any work that may affect the signal system. The work of this project includes working within constrained work windows on a live railroad consisting of freight trains, inter-city passenger trains, and Metrolink commuter trains. Candidates shall have a similar level of experience. The Engineer's decision concerning the candidate's qualifications will be final. Begin no signaling related work prior to obtaining the Engineer's approval Signal Managers. Obtain Resident Engineer's approval for additional Signal Managers as required depending upon the level and type of work being performed.
- H. Propose alternate personnel if the original candidate is found unacceptable. Previous qualification as a Signal Engineer or Manager on other Metrolink projects does not constitute qualification as a Signal Engineer or Manager for this Contract.
- I. The Resident Engineer reserves the right to disqualify any Signal Engineer, Signal Manager, or Signal Electrician at any time during the Work. This right is at the sole discretion of the Resident Engineer and is not subject to protest or appeal.
- J. The Signal Electricians shall have a minimum 1,000 hours of experience in the wiring and installation of railroad signal and grade crossing warning system circuits, components, control equipment and associated devices including their primary and backup power supply systems. Signal Electricians shall perform the wiring, labeling and connection/continuity/resistance testing, as appropriate, of all railroad signal and grade crossing warning system circuits, components, control equipment and associated devices including their primary and backup power supply systems. All Signal Electricians shall be licensed: Journeyman or Inside Electricians or an approved equal. Signal Electricians shall be paid at the prevailing wage rate for the locality of the construction.

- K. All Contractor field personnel shall receive safety training in accordance with Section 01 43 23, Contractor Qualifications and Requirements, 01 35 23, SCRRRA Site Safety Requirements, and 01 56 37, Worksite Security Requirements.

#### 1.10 AS-BUILT DOCUMENTATION

- A. Refer to Section 01 78 39, Project Record Documents, for requirements preparation and submittal of Record Documents.
- B. The following as-built documentation requirements augment requirements specified in Section 01 78 39, Project Record Documents. After a location is placed in service, submit as-built documentation as follows:
  - 1. Submit four copies of all as-built circuit plans and documents to the Resident Engineer within 3 business days.
  - 2. Civil Drawings which show the physical location of all signal apparatus and conduits, both along the tracks and perpendicular to it, and heights of all signal structures within 60 days.
- C. Annotate the As-Built drawing sets to show all approved circuiting and wiring changes made during installation and testing of the location prior to placing it in service, and any approved changes made after placement in service. Clearly identify all changes on the Drawings using the "Red In"/"Yellow Out" convention. Changes shall be dated and initialed by the Contractor's responsible Signal Engineer. Identify the date that the location was tested and placed in service in the revision block of the Drawings.
- D. In addition to the as-built Drawings provided to the Engineer, one set shall be bound and shall be kept in the instrument enclosure at a location and manner approved by the Engineer. As-built Drawings shall be clean and legible. The as-built Drawings shall not be removed from the field location after the location is placed in service without the prior written approval of the Engineer.
- E. The final as-built Drawings shall be 11 inches by 17 inches, unless authorized by the Engineer to substitute another size.
- F. Each circuit that continues to another drawing shall be annotated with drawing number and routing information for the continuation of the circuit.
- G. The circuit Drawings shall show all individual circuits. Typical circuits will not be accepted.
- H. The location plans shall show all cables installed with the number of conductors, the size of conductors, the type of cable, termination points of conductors, and the circuit on each conductor. Separate cable plans shall be drawn if cable information cannot be shown in a neat and organized manner on the location plans.

### 1.11 TRACK AVAILABILITY REQUIREMENTS

- A. General: Refer to Sections 01 35 15, Maintenance and Protection of Railroad Traffic for track access and related provisions. Metrolink Commuter Service and any other passenger or freight service may not be interrupted by the Work of this Contract, except as provided in the Contract Documents.
- B. Signal cutovers may be required under traffic.
- C. Signal cutovers will require coordination between the Contractor, Metrolink, other railroads, as applicable, to keep train delays to a minimum.

### 1.12 BID ITEM LIST

- A. Submit the Bid Item List for signal bid items as required under Section 01 29 73, Schedule of Values, and in accordance with the following additional requirements:
  - 1. Bid Item List for the signal bid items shall include all interface circuits and staging necessary to place the location in service at each stage, all acceptance testing and transportation of materials, all equipment rental, all pretesting and removal of old equipment.
  - 2. Organize Bid Item List for signal bid items to assign a value to each signal location. A location is defined as a grade crossing warning system, a hazard detector system, an intermediate signal location, or a control point.

### 1.13 WARRANTY

- A. Provide warranties for all equipment and material covering parts and labor for two years from the date equipment or material is accepted by the Owner.
- B. All warranties shall comply with the requirements of Section 01 78 36, Warranties and Guarantees, unless otherwise specified herein.

## PART 2 – PRODUCTS

### 2.01 EQUIPMENT – GENERAL

- A. Signaling materials and equipment shall be the products of manufacturers regularly engaged in the production of such material and equipment and shall be the manufacturer's latest design. The materials and equipment shall have shown proven performance in North America for a minimum of 5 years. Materials and equipment shall be delivered to the job-site in unbroken packages, reels, or other forms of containers.
- B. All materials and equipment shall conform to the recommendations of AREMA Signal Manual, except as modified in the Specifications and Contract Plans.



- C. Reference to specific equipment and manufacturers is intended to establish quality, overall design, and fit, subject to compliance with all criteria specifications. Equipment equal to, or exceeding, the specifications and requirements may be used subject to Section 01 25 00, Substitution Procedures, and the Resident Engineer's written approval. Should alternate equipment be accepted, perform all necessary work to fit the alternate equipment to these specifications and to revise the Contract Plans accordingly.

## 2.02 ELECTRICAL AND ELECTRONIC COMPONENTS

- A. All Contractor provided electrical and electronic component materials furnished under this contract shall be new.

Design and construct fusing of all DC power supplies and circuitry according to the following requirements:

1. Circuit breakers and fuses shall be the correct side-band rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.
2. Fuses shall be sized to protect the wire.
3. Fuses shall be in the positive leg of the power supply.
4. Fuses shall be of the nonrenewable indicating type.
5. All branch feeds for a circuit shall be from the same fuse to prevent fuse cascading due to branch fusing carrying loads for other circuits.
6. Loads shall be divided so that no normal operating current is more than 75 percent of the fuse rating.
7. Fusing shall be functionally oriented to minimize the equipment affected by a blown fuse (i.e., per track, switch control circuits, etc.)
8. Fuse clips shall be constructed to retain their resilience under all installation and service conditions and to ensure a positive contact between the clips and the fuse.

- B. Printed Circuit (PC) Cards and Connectors:

1. The PC cards shall be mounted in 19-inch card files unless otherwise approved by the Engineer.
2. The PC wiring shall be organized so that wires serving the same function shall be connected to the same terminal of PC cards. PC cards containing the same circuitry and programming, where applicable, shall be interchangeable between subsystems.

3. The design and construction of PC cards of the same subsystems shall be the same. Cards of different subsystems shall be of the same design and construction wherever practicable.
  4. PC cards shall be of glass epoxy construction. Card material shall meet the requirements of NEMA, Type FR-4. Cards shall have sufficient thickness to permit easy insertion and removal and shall be physically keyed to protect against incorrect interchange. Circuits shall be formed by etching. Conductor material shall be copper and shall be protected from exposure to air.
  5. PC cards containing components that may be damaged if a plug connector or plug-in unit is removed while the equipment is energized shall be clearly identified in the equipment maintenance manual. PC cards shall be marked or labeled with a warning note on the individual board, be conspicuously located on the module, or by an alternate means as approved by the Engineer. A means shall be provided to remove power from the module or card file.
  6. Components mounted on the PC card, weighing more than 1/2 ounce or with a displacement of more than 1/2 cubic inch, shall have a mechanical supporting attachment to the card separate from all electrical connections.
  7. Do no stacking or piggybacking of PC sections to accomplish changes or modifications to wiring or components on printed circuit cards.
  8. Connectors shall have plating with a minimum thickness of 0.00005 inch.
- C. Printed Circuit Card Files:
1. There shall be not more than one type of card file for each size of PC card. The card file plug boards shall be registered to agree with the registry of the associated PC card. PC cards shall not project beyond the front of the equipment rack when mounted in the card file.
  2. Card files shall be installed in dust-proof cabinets and protected with dust covers.
  3. Insulated cable clamping devices shall be located on the back of the file in such a way that wires terminating in the files shall be installed in a neat and secure bundle, rigidly supported, and protected to prevent chafing of insulation. Cabling provision on the file shall permit wires to enter or leave the file from both the right and left sides. Such cabling shall not restrict access to the card file when the rear covers of the card files are removed.

## 2.03 SHOP FINISHES

- A. Factory finish signal equipment with the exception signal system parts which are stipulated as field finished in AREMA C&S Manual, Part 1.5.10, and aluminum alloy and galvanized metal components. If manufacturer typically provides

factory painted finish for aluminum alloy and galvanized components, include such information in equipment submittals for Engineer's acceptance.

- B. Finishes shall comply with AREMA C&S Manual, Part 1.5.10, signal equipment manufacturer's standards, and provisions specified herein. It shall be understood that where AREMA C&S Manual, Part 1.5.10, uses the word "should" that the word "shall" shall be substituted except as accepted by the Engineer in writing.
  - 1. Finish terminal boards and interior of shelters with white gloss fire retardant paint.
  - 2. Factory finish signal equipment with aluminum paint except as otherwise specified herein and in the AREMA C&S Manual.
  - 3. For signal system parts which the AREMA C&S Manual stipulates as shop primed and field finish, shop prime in accordance with requirements specified in Section 09 90 00, Painting and Coating and 09 96 23, Graffiti Resistant Coating.
  - 4. For signal system parts which the AREMA C&S Manual stipulates to receive shop prime and finish coats followed by field finish coat, coordinate shop finish coat with field finish specified in Section 09 90 00, Painting and Coating and 09 96 23, Graffiti Resistant Coating.

#### **2.04 FIELD PAINT MATERIALS**

- A. Field finish as specified in Section 09 90 00, Painting and Coating and 09 96 23, Graffiti-Resistant Coating and AREMA C&S Manual, Part 1.5.10. Exterior surfaces shall receive a heavy duty finish system.
- B. Touch-up Paint for Signal Manufacturer Finishes: Touch-up paints recommended by signal manufacturer, including aluminum touch-up paint.

### **PART 3 – EXECUTION**

#### **3.01 INSTALLATION**

- A. Contractor shall make all necessary modifications to the existing signal system, protect or relocate existing cabling, signals, switches, and signal shelters; and modify associated signal and highway grade crossing systems to ensure the existing signal system operates as intended during construction and installation of the new signal system. Protect signal and highway grade crossing systems to ensure train operations are not interrupted and safety is maintained.
- B. Contractor shall take no action which will violate any rule or regulation as specified by CFR 49, the General Code of Operating Rules, timetable instructions, general order, bulletin, or special instruction; which will reduce the integrity of the signal system; or endanger railroad personnel, the public, or employees.

- C. All equipment installation as described herein or as shown in the Contract Plans shall be in accordance with the SCRRA Engineering Standards.
- D. Ensure that equipment within the instrument shelters and relay cases is securely anchored or otherwise fastened in enclosure upon completion of enclosure installation. Securing equipment shall not negate the requirements to maintain isolation between ground systems as otherwise called for in these Specifications.
- E. An updated, detailed set of the approved signal design Drawings shall be kept at each field location for equipment as it is placed in-service as system changes are made.

### **3.02 FIELD FINISHES AND TOUCH UP**

- A. For signal system parts which AREMA C&S Manual, Part 1.5.10, stipulates as shop primed and field painted, field finish as specified in Section 09 90 00, Painting and Coating and 09 96 23, Graffiti-Resistant Coating and AREMA C&S Manual, Part 1.5.10, including requirement to apply one field coat prior to field assembly and one field coat following field assembly.
- B. Touch-up signal manufacturer's finishes after installation.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. General Signal Requirements 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 work and services included in Sections 34 42 10, Coordination with SCRRA Procurement Contractor; 34 42 38, Interlocking Controls; 34 42 40, Solid State Coded Track Circuits; and 34 42 56, Signal Grounding; 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.
- C. Demolition and Removal of Existing Equipment including retiring of CPs, Grade Crossings, Signals, Gates, and Cabling 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. General Signal Requirements 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.
- C. Demolition and Removal of Existing Equipment including retiring of CPs, Grade Crossings, Signals, Gates and Cabling 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 34 42 10**

### **COORDINATION WITH SCRRA PROCUREMENT CONTRACTOR**

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

##### **1.01 SUMMARY**

- A. This Section includes requirements coordinating installation, inspection, and testing of new Owner furnished material with the Engineer and with the Owner's procurement contractor. Notify the Engineer in writing a minimum of 30 days prior to any installation, inspection and testing of such material.
- B. Refer to Section 01 64 00, SCRRA Furnished Material and Equipment, in the paragraph "Materials furnished by the Authority".

##### **1.02 SUBMITTALS**

- A. Submit Acceptance Test Procedure documentation on all Owner Furnished Equipment prior to transport of the equipment.

##### **1.03 WARRANTY**

- A. Because the manufacturer's warranty for materials begins when the material is received, the Contractor shall supplement the manufacturer's warranty for the amount of time elapsed between its receipt of the material and the Owner's final acceptance, and as required under Section 01 78 36, Warranties and Guarantees. The supplemental warranty shall include all costs to repair or replace material which is damaged while in Contractor's care or fails prematurely and as required under Section 01 78 36, Warranties and Guarantees. Make arrangements for and pay costs of such repairs performed by and replacements provided from the original equipment manufacturer.

#### **PART 2 - PRODUCTS**

##### **2.01 SOURCE QUALITY CONTROL**

- A. Test all Owner-furnished equipment before transporting it to the job site. Conduct this acceptance testing for all equipment in accordance with the Contractor's Acceptance Test Procedure. Prior to transportation, submit a copy of the documentation of acceptance testing to the Engineer.

#### **PART 3 - EXECUTION(NOT USED)**

- A. 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.
- 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 34 42 10**

**SECTION 34 42 16**  
**SIGNAL WIRE AND CABLE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for all cable and wire required for signal and signal power system wiring to wayside shelters, crossing shelters, junction boxes, factory wired mechanisms and other signal equipment.
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 31 20 00 – Earthwork
  - 2. Section 34 42 58 – Signal System Testing
  - 3. Section 34 42 60 – Signal System Miscellaneous Products

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- B. Southern California Regional Rail Authority (Metrolink) Engineering Standards
- C. International Organization of Standardization (ISO):
  - 1. 9001 - Quality Management Systems Requirements.

**1.03 SYSTEM DESCRIPTION**

- A. Material and workmanship shall be of the highest quality, assuring durability for minimum life expectancy of 40 years. Cables shall be suitable for use in the environment to be encountered on a railroad signal system, and shall be certified for continuous operation, in wet or dry locations, with no conductor failing in continuity or with loss of insulation to cross or ground less than one mega ohm.

**1.04 SUBMITTALS**

- A. Product Data: Manufacturer's catalog cuts, material descriptions, and specifications for each type of wire and cable the Contractor proposes to provide.
- B. Product Sample: The Contractor shall submit one (1) foot of sample cable when requested by the Resident Engineer. Resident Engineer shall make request in writing prior to approval, if deemed necessary, to ensure the product data submittal meets the specification.



- C. Quality Assurance: Submit a list of cable manufacturer's installations complying with the past performance and experience requirements specified herein.

### **1.05 QUALITY ASSURANCE**

- A. Cable manufacturer's qualifications shall be as follows:
  - 1. Past Performance and Experience: Demonstrated previous successful experience in supplying cable to the railway or transit industry for use as vital signal control cables. A list of such installations shall be provided for each cable manufacturer to be considered.
  - 2. Quality Assurance Program: The manufacture of cables in accordance with the requirements of these specifications shall be accomplished in compliance with a Quality Assurance Program that meets the intent of ISO 9001.
  - 3. All signal wire and cable furnished under this Contract shall be provided as new and shall not be installed under this Contract if the manufacture date of the cable exceeds 24 months prior to the Notice-To-Proceed date.

### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Shipping, storage, and handling shall be in accordance with AREMA Signal Manual, Part 10.4.1.
- B. During storage and handling, prior to final conductor termination, cable ends shall be sealed to prevent the entrance of moisture.

## **PART 2 – PRODUCTS**

### **2.01 INTERNAL WIRE AND CABLE**

- A. Individual cable make-up and conductor sizes shall be as shown on the Contract Plans.
- B. Internal wire and cable shall conform to AREMA C&S Manual, Part 10.3.14, and the following requirements:
  - 1. Solid conductors shall be Type I in accordance with AREMA C&S Manual Part 10.3.14.
  - 2. Stranded conductors shall be Type II in accordance with AREMA C&S Manual Part 10.3.14.
- C. Internal wire and cable insulation shall conform to AREMA C&S Manual Part 10.3.24 and the following requirements:
  - 1. The minimum insulation rating shall be 600 volts.

### **2.02 EXTERNAL WIRE AND CABLE**

- A. General
  - 1. Individual cable composition and conductor sizes shall be as shown on the Contract Plans.
  - 2. Conductors shall be soft or annealed copper, coated with tin in accordance with Type I wire as shown in the applicable AREMA C&S Manual Part.
  - 3. Stranded conductors shall be soft or annealed copper, coated with tin in accordance with Type II wire as shown in the applicable AREMA C&S Manual Part.
- B. Track Wire
  - 1. Twisted track wire shall be Okonite-Okolene (EP-PE) manufactured by Okonite Co. or approved equal.
  - 2. Track wire shall meet the requirements of AREMA C&S Manual, Part 10.3.15.
- C. Signal, Switch, and Express Cable
  - 1. Wire and cable used for signals, switches, and express cable shall be Okonite (EP) Armored Underground Signal Cable manufactured by Okonite Co. or approved equal.
  - 2. Conductors number six (#6AWG) and smaller shall be solid. Conductors number 4 (#4AWG) and larger shall be stranded.
  - 3. Armored cable shall be furnished with a 10-mil flat bronze tape between the conductors and the outer jacket, helically applied, and adequately cushioned from the conductors.
  - 4. Armored cable shall meet the requirements of AREMA C&S Manual, Part 10.3.17.
- D. AC Power Cable
  - 1. AC power shall be Okonite-FMR (EP) Okolon (CSPE) Type TC Cable manufactured by Okonite Co., or an approved equal.
  - 2. Cable shall meet the requirements of AREMA Signal Manual, Part 10.3.16.
- E. Modem Cable
  - 1. Modem cables shall be C-L-X Type SP-OS manufactured by Okonite Co. or approved equal.

2. Modern cable shall be protected by a moisture impervious, continuously welded, corrugated, aluminum sheath with an overall EFTE fluoropolymer jacket.
3. Individual twisted pairs shall be separately shielded with an aluminum polyester tape to provide shield isolation between pairs of 100 mega ohms per 1000 ft. minimum.
4. Modern cable shall meet the requirements of AREMA Signal Manual, Part 10.3.17 except as specified herein.

### **2.03 SOURCE QUALITY CONTROL**

- A. Coordinate with the Engineer for Engineer's inspections and tests at point of production. The Engineer shall have the right to make inspections and tests, as necessary, to determine if the wire or cable meets the requirements of this Specification. The Engineer shall have the right to reject wire or cable that is defective in any respect.
- B. Provide, at the point of production, apparatus and labor for the following tests:
  1. Conductor size and physical characteristics.
  2. Insulation HV and IR tests.
  3. Physical dimension tests.
  4. Special tests on materials in coverings.
  5. Final HV, IR, and conductor resistance tests on shipping reels.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. General:
  1. The installation of wire and cable shall conform to AREMA C&S Manual Parts 10.4.1, 10.4.30, except as specified herein.
  2. All external cable runs shall be in conduit in accordance with the Metrolink Engineering Standards, and as called for in the Contract Documents.
  3. The signaling cables shall be separated from parallel run of ac feeder cables, where adjacent locations are fed from one ac service location.
  4. Give the Engineer 24 hour notice prior to installing cables.
  5. Provide sufficient slack in cable conductors at all terminating posts to enable a minimum of three re-terminations of the conductor, due to broken eyelets without re-servicing or re-pot heading the cable.

6. In certain types of installation, the cable cannot be constrained; therefore, ample cable slack shall be provided for additional flexibility due to vibration of such equipment.
7. Do not bend cables to a radius less than manufacturer's recommendation.
8. Distribution cable runs shall be continuous without splices between cable terminating locations. Express cable runs longer than cable lengths shall be spliced together in junction box, instrument case, or other acceptable shelter. Prior to any cable or wire splicing, obtain the Engineer's approval. Approval will not be granted for cables damaged by the Contractor or vandalized by others. It is the responsibility of the Contractor to protect all cables until final installation acceptance.
9. Identify individual cable conductors at each cable termination with plastic tags, as specified in Section 34 42 60, Signal Systems Miscellaneous Products. Identify and terminate all spare conductors in each cable.
10. Seal cable entrance openings in equipment enclosures and junction boxes with either compression type fitting or pliable sealing compound after the cable is in place. Use sealing compound to seal the area around cable where the cable emerges from the end of a conduit or pipe. Seal and plug all spare conduits. Seal around conduits where conduits enter enclosures to prevent entry of vermin and insects.
11. Wherever multiple conductor cables are terminated, carefully remove the outer sheath of the cable to a minimum point of 3 inches from the cable entrance. At the end of the cable sheath or covering, apply two layers of Scotch 88 plastic electrical tape or approved equal.
12. Terminate all cable conductors in number sequence from top to bottom.
13. Cable shields or sheaths shall be grounded at the entrance to signal shelters and shall float when terminated in field apparatus.

**B. Underground Buried Installation**

1. When crossing beneath tracks, bury conduit(s) to a uniform minimum depth of 36 inches as measured from bottom of tie to top of conduit(s). When paralleling the tracks, bury conduit(s) a minimum depth of 36 inches as measured from the finished grade to top of conduit(s). Provide backfill and compaction as specified in these Specifications. Install cable within four-inch PVC schedule 80 conduit when passing beneath tracks or crossing a roadway. Install cable within four-inch PVC Schedule 40 conduit(s) when paralleling the tracks.
2. Upon written request from the Contractor and only under extreme circumstances because of installation hardship will installation of conduit(s) be allowed to a depth of less than 36 inches and is subject to the Resident

Engineer's approval. The Contractor shall protect the conduit(s) and cable(s) in a manner acceptable to the Resident Engineer.

3. Ensure that whenever any signal conduit(s) is to pass beneath pavement or roadway, and if conduit is not provided by others, the Contractor shall provide and install cable(s) in 4-inch PVC Schedule 80 conduit and extend schedule 80 conduit(s) a minimum of 2 feet beyond the edge of the curb and gutter and/or sidewalk, where applicable. Installation of conduit(s) and pull box(es) shall be in accordance with Metrolink Engineering Standards. Restore pavement and roadway to its original condition including striping and markers, subject to local municipal requirements and the Resident Engineer's acceptance.
  4. Whenever any signal cable is to pass under the hot-mix asphalt concrete (HMAC) underlay installed on the project, provide and install cable(s) in conduit(s) with pull boxes in accordance with the Metrolink Engineering Standards.
  5. Where cable leaves the ground at other than buildings or in foundations, protect cable by a bootleg or other covering extending above the ground line. Fill top of such protective coverings with a sealing compound.
  6. Where underground cables enter a concrete foundation, junction box, shelter or case, leave sufficient slack in each cable in the nearest pull box to allow a minimum of an additional one foot of cable to be pulled into the shelter or junction box.
  7. Ensure that the pot heading of underground cables shall be applied whenever cable is terminated in signal equipment, and such termination is within two feet of the grade level. This neoprene and seal pothead shall be installed in accordance with the manufacturer's instructions.
  8. The Contractor shall ensure that cable(s), track wire, and conduit(s) shall be installed per Contract Plans and Section 31 20 00, Earthwork.
  9. Cables shall not cross one another when they are pulled into a conduit or pipe; the conductors shall not be pulled tight or kinked in conduit fittings or boxes. All cables to be installed in a conduit or pipe shall be pulled and installed simultaneously.
  10. All cables, except final connection of flex wires to rail, shall be installed in a conduit system as shown on the Contract Plans and as required within the Metrolink Engineering Standards.
- C. Special Protection: Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions, such as vibration or sharp corners on equipment. Replace any cable that is installed but subsequently damaged prior to acceptance because of the Contractor's failure to provide such special protection.
- D. AC Power Cable

1. Provide and install AC power cable dedicated conduit from the service meters to the signal shelters and between signal shelters.

#### E. CABLE PULLING

1. Perform cable pulling into conduits in accordance with the cable manufacturer's requirements and with the requirements specified herein.
2. Do not use poly rope for any mechanical means of pulling cable. Poly rope stretches when subjected to high tension and can create a hazard. Manual pulling (by hand) using poly rope is allowed. When using a mechanical means to complete a pull, a Samson rope or equivalent, flat line, shall be used, as it does not stretch in the same way that poly rope does, and presents less of a hazard.
3. Provide two-way voice communication and adequate resources at both feeding and pulling ends of the run and at any interim location (e.g., 4 X 4 pull boxes). Apply cable pulling lubricant liberally during the cable pull. To minimize back reel tension, accelerate slowly and smoothly from rest to a constant pulling speed. Avoid stopping the pull midway through the installation; the drag due to friction is greatly increased when pulling is restarted.
4. The cable that cannot be pulled in manually shall be installed by means of a cable puller, an electric winch or a winch on a radial boom derrick. In each case, the machine operator shall have access to a means of determining the pulling tensions on the cable (e.g., gauges which indicate direct line pressure or gauges which indicate hydraulic pressure which can be converted to line tension via a conversion table or a dynamometer). Do not exceed the manufacture's pulling tension for any cable installation. Cable pulling with trucks, backhoes, crane/boom or any other method whereby the amount of pulling tension is not measurable, is unacceptable.
5. Establish the direction of the pull based on safe pulling tensions, sidewall bearing pressure calculations and minimum bending radius for a specific cable to be installed. Do not exceed the minimum bending radius at any time. Follow the manufacturer's instructions for the safe pulling tension and determine if the cable pull requires a basket grip or a pulling eye attached to the conductor. Basket grips or pulling eyes shall be attached to the pulling rope or cable by an appropriately sized swivel head. Rod each conduit with an appropriate size brush and mandrel to ensure conduits are properly fitted and they are clean and free of all dirt, stones, scale, water etc. For installation in conduit, place cable guides wherever necessary to avoid abrasion and/or damage to the cable e.g., when guiding the cable from the reel to the conduit mouth or trench, when passing through or exiting manholes, when exiting a conduit run. Cable guides shall be in the form of large diameter, smooth-surfaced free turning sheaves or rollers. They shall be designed to ensure that cable will not ride off the end of the roller or be pinched into a sheave contour. Guide tubes or chutes shall be used provided they have a smooth burr-free working surface, well flared

entrances, largest possible bending radius and are securely fastened so that the cable passes smoothly over them. In any case, equipment shall be installed to ensure the minimum bending radius of the cable is not exceeded. Using suitable reel mounting equipment, locate and position the reels such that cable tension at the feeding end is minimized. Select pulling equipment, which can provide smooth speed control at the anticipated tensions. Ensure the pull rope or flat line has the required tensile rating. Avoid the use of elastic materials.

6. Pre-lubricate conduit with cable manufacture's recommended cable lubricant. Setup lubrication points along the conduit run (e.g., feed in point, 4 X 4 etc. to reduce pulling tension and abrasion to the cable jacket). For long heavy pulls, pre-lubrication of conduit and pull rope is essential to prevent abrasion at the bends, particularly PVC conduit bends, which can become softened due to frictional heating. In the case of long conduit lengths or excessive curvatures in the conduit the cable may have to be pulled in from two directions. Follow the recommendations of the cable manufacturer as to the amount of lubricant to be applied, which is depended on the size and length of the conduit system into which the cable is being pulled.

### **3.02 REPAIR**

- A. Immediately call to the Engineer's attention any instance of damaged cable observed at any time, whether prior to installation, occurring during construction, or discovered by test observation after installation. The method of correction shall be in accordance with the Engineer's written instruction. Promptly perform repairs or replace damaged cables.

### **3.03 FIELD QUALITY CONTROL**

- A. Test all installed external cable in accordance with the requirements of Section 34 42 58, Signal System Testing, and AREMA C&S Manual, Part 10.4.30.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Cables 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. Case and house wiring 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. Cables and Wires 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. Field Case and House Wiring 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. 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.
- D. The Contractor shall allow for 100 wiring changes, not shown on the Contract Plans and requested by the Engineer, at no additional cost. A wiring change shall consist of connecting or removing a wire. Thus, moving a wire from one contact terminal to another contact terminal will consist of two wiring changes.

**END OF SECTION**



**SECTION 34 42 18**  
**CONDUIT AND PULL BOXES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Furnishing conduit, pull boxes, handholes and associated materials as specified herein.
- B. Material and workmanship shall be of the highest quality, assuring durability for minimum life expectancy of 40 years. All pull boxes, handholes, PVC conduits, HDPE conduits, fittings, cement and other materials to be furnished shall be suitable for use in the environment to be encountered on a railroad signal system. Conduits shall be used in underground, encased or exposed applications in accordance with National Electrical Code, Article 347.

**1.02 RELATED SECTIONS**

- A. Related Specification Sections include, but are not limited to:
  - 1. Section 01 14 49 Coordination with Utilities
  - 2. Section 31 20 00 Earthwork
  - 3. Section 34 42 00 General Signal Requirements

**1.03 REFERENCES**

- A. Southern California Regional Rail Authority (Metrolink) Engineering Standards
- B. Applicable Local Ordinances
- C. The following General Orders (most current) of the State of California Public Utilities Commission (CPUC) shall apply:
  - 1. General Order 118: Construction, Reconstruction, and Maintenance of Walkways and Control of Vegetation
  - 2. General Order 128: Construction of Underground Electric Supply and Communication Systems

**1.04 SUBMITTALS**

- A. Submit in accordance with Section 01 33 00, Submittal Procedures.
- B. The Contractor shall submit manufacturer's catalog cut sheets, material descriptions, and specifications for each type of conduit, type of handhole, fittings, type of pull box and other materials the Contractor proposes to provide.

- C. The Contractor shall submit for review and approval its proposed plan for final installation of conduits and pull boxes prior to constructing underground facilities. The proposed plan shall be redlined onto Metrolink's PTC Composite Map Plan and Profile for the relevant project area, or another method approved by the Engineer. The Contractor shall not use the signal duct bank plan in the Contract Drawings for this purpose.

### **1.05 QUALITY ASSURANCE**

- A. Conduit manufacturer's qualifications shall be as follows:
  - 1. Quality Assurance Program: the manufacturer of conduits, handholes and pull boxes in accordance with the requirements of this Specification shall be accomplished in compliance with a Quality Assurance Program that meets the intent of the American Society for Quality (ASQC) Standard C1.

### **1.06 INSPECTION**

- A. The Commission shall have the right to make inspections and tests, as necessary, to determine if the materials meet the requirements of the Specification. The Resident Engineer shall have the right to reject material that is defective in any respect.

### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Contractor shall immediately replace any conduit or pull box that is damaged at any time, prior to final acceptance by the Resident Engineer without additional cost.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. 4" schedule 40 PVC conduit, in 20 ft. lengths.
- B. 4" schedule 40 PVC elbows, varying from 22 ½ degree curve to 90 degree curve and 24" in length
- C. 4" rigid galvanized conduit, in 10 ft. lengths.
- D. 2.375" schedule 40 HDPE conduit.
- E. 12/10-mm HDPE mini duct and couplers
- F. 6" burial caution tape
- G. PVC Cement
- H. 4'-0" x 4'-0" x 4'-0" Concrete Pull Box with Bolt Down Steel Cover

**2.02 SCHEDULE 40 PVC CONDUIT AND FITTINGS**

- A. Conduit shall be rated for use with 90 degree C Conductors, shall be UL listed, and shall comply with National Electric Manufacturers Association (NEMA) Specification TC-2 (conduit) and TC-3 (fittings).
- B. Conduit and fitting shall carry a UL label and shall be identified by type and manufacturer and shall be traceable to location of plant and date manufactured. Labels shall be legible and permanent.
- C. The conduit shall be made from polyvinyl chloride compound which includes inter modifiers to improve weatherability and heat distortion.
- D. Conduit shall be free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could damage cables or conductors.
- E. Conduit and fittings shall be solvent cemented in applications in accordance with instructions from the manufacturer.

**2.03 RIGID GALVANIZED CONDUIT**

- A. Conduit shall be rated for use with 90 degree C Conductors, shall be UL listed, and shall comply with ANSI Specification C80.1.
- B. Conduit shall carry a UL label and shall be identified by type and manufacturer and shall be traceable to location of plant and date manufactured. Labels shall be legible and permanent.
- C. Conduit shall be hot-dipped galvanized inside and out. Conduit shall be coated with an organic layer to inhibit white rust and increase corrosion resistance.
- D. Conduit shall be threaded on both ends, with a threaded coupler attached on one end to allow joining of multiple conduits.

**2.04 HIGH DENSITY POLYETHYLENE CONDUIT**

Conduit shall be high density polyethylene (HDPE) suitable for direct burial and plowing installation with the ballast portion of the track structural section. Corrugated innerduct is not acceptable.

- A. HDPE conduit supplied shall comply with ASTM D2447, schedule 80, 2.375" O.D., black with an orange stripe in color, ribbed interior and smooth exterior. Ribbed interior wall shall be lubricated to reduce friction when installing fiber cable.
- B. Equivalent material shall meet the minimum requirements of SDR 11 – ASTM D303 or SDR 9 – ASTM D2239
- C. HDPE conduit shall be an extruded coilable tube supplied on reels at a minimum of 5000 ft. lengths.

- D. HDPE conduit shall be capped at both ends prevent any undesirable contaminates from entering tubes.
- E. HDPE conduit shall be supplied with factory installed pull lines.

## **2.05 HDPE MINI DUCT AND COUPLER**

- A. HDPE mini duct shall be Fiber-Guard/MD as manufactured by ARNCO Corporation or approved equal.
- B. HDPE mini duct conduit shall be supplied on reels of a minimum of 5000' foot lengths.
- C. HDPE mini duct conduit shall be capped at both ends with air tight blank plugs to prevent any undesirable contaminates from entering tubes.
- D. HDPE mini duct conduit shall be 12/10-mm and shall be available in colors of blue, orange, yellow and green.
- E. HDPE mini duct shall be factory pressure tested per the manufacturer's recommendations. Mini duct shall hold 130 psi to ensure there are no leaks.
- F. Coupler for mini duct shall be as manufactured by ARNCP Corporation P/N 1-905694 or approved equal.

## **2.06 DETECTABLE UNDERGROUND TAPE**

- A. Detectable underground tape shall conform to the following specifications:
  - 1. NTSB-PSS-73-1
  - 2. American Gas Association 72-D-56
  - 3. OSHA 1926-956 (c) (1)
  - 4. DOT Office of Pipeline Safety USAS B31.8
  - 5. API RP 1109
  - 6. APWA Uniform Color Code
- B. Tape shall be easily located with an industrial grade non-ferrous metal detector and shall have highly visible colors to assist in location when digging.
- C. The label on underground tape shall read:

**CAUTION  
METROLINK COMMUNICATIONS  
CABLE BURIED BELOW**

**2.07 PVC CEMENT**

- A. Contractor to provide medium-bodied, fast setting solvent cement that shall have a strong, leak-tight seal.
- B. PVC cement shall conform to NEMA and UL specifications.

**2.08 PULL BOXES**

- A. Pull Boxes shall conform to SCRRRA's Engineering Standard ES8225.
- B. Precast concrete vaults and access doors shall be designed for H-20 highway vehicle loading.
- C. All exposed portions of the vault shall be non-conductive to electricity.
- D. The minimum inside dimensions measured just below the lid support shall be 4' wide x 48" long.
- E. The depth of the vault, when measured from the top of the access doors, shall be 48".
- F. Covers shall be two individual galvanized diamond steel pieces with hex bolts to fasten in place. Covers shall have a skid resistant surface and be equipped with lifting eyes.
- G. Pull boxes shall be manufactured by Jensen Precast, or approved equal.

**PART 3 - EXECUTION****3.01 INSTALLATION**

- A. General
  - 1. The installation of conduit and pull boxes shall conform to the AREMA C & S Manual, except as specified herein.
  - 2. The installation of conduits, vaults, and pull boxes shall conform to the requirements of the Metrolink Engineering Standards, or as required in the Contract Documents.
  - 3. Separate conduits shall be afforded for power distribution cables.
  - 4. The Contractor shall install conduits, vaults, and pull boxes according to the approved plan for final installation of conduits and pull boxes. Deviation from the approved final plan must be in writing from the Resident Engineer.
  - 5. Total bend radius allowed for a single conduit run shall not exceed 360 degrees. A single conduit run is defined as the conduits extending between pull boxes, vaults, or instrument enclosures without interruption. Bends

afforded for conduit risers into instrument enclosures are to be considered as part of the total bend radius calculation.

6. All vault openings and knockouts shall be sealed with mortar. All conduits extending into the sides of vaults shall be cut flush with the pull box wall.
7. Ensure proper drainage is provided in in the bottom of pull boxes or vaults. A layer of gravel shall be installed per Metrolink Engineering Standards below the pull box or vault.
8. The Contractor shall maintain required CPUC walkways around pull boxes.
9. All pull boxes installed into dirt or parkway areas shall have a concrete cap around the box.
10. Pull boxes shall not be installed in any part of a driveway, wheelchair ramp, or other travelled way unless specified in the Contract Documents or approved by the Resident Engineer.
11. Contractor shall protect all pull boxes from damage; damaged sections of pull boxes shall be replaced with new at the Contractor's expense.
12. All pull boxes to be abandoned shall be removed completely by the Contractor and the existing sidewalk, parkway and landscaping shall be repaired.
13. Any work performed by the Contractor that impacts or involves any commercial utility facility shall be performed by a contractor approved by the commercial utility and shall be governed by the utility's standards. Contractor accepts all liabilities and responsibilities when undertaking repairs, modifications and additions involving commercial utility ducts, handholes and cables.

**B. Underground Buried Installation**

1. Bury conduit to a uniform depth of 36 inches as measured from bottom of tie to top of the conduit. When paralleling the tracks, bury conduit a minimum depth of 36 inches as measured from the finished grade to top of cable. Lay conduits loosely in trench with a sand bed and backfill as specified in these Specifications.
2. Upon request and only under extreme circumstances because of installation hardship will installation of a conduit be allowed to a depth of less than 36 inches, subject to the Resident Engineer's acceptance. Protect the conduit in a manner acceptable to the Resident Engineer.
3. Whenever any conduit is to pass under pavement or a roadway, install 4-inch PVC Schedule 80 conduit and extend conduit 2 feet beyond the edges of the pavement or roadway. Installation of conduits and pull boxes shall be in accordance with Metrolink Engineering Standards. Restore pavement or

roadway to its original condition, subject to the Resident Engineer's acceptance.

4. Whenever any conduit is to pass under the hot-mix asphalt concrete (HMAC) underlay installed at an interlocking, ensure the conduit is protected against the damage from the heat of the HMAC.
  5. All exposed conduits shall be Galvanized Rigid Steel (GRS).
  6. Once the Contractor has finished conduit installation, and prior to installing cables or wires, the Contractor shall mandrel the conduits and install a pull rope into each conduit.
- C. Special Protection: Provide appropriate special protection for conduits, vaults or pull boxes in areas where they are unavoidably exposed to hazardous conditions, such as vibration or other equipment. Replace any conduit, vault, or pull box that is installed but subsequently damaged prior to acceptance because of the Contractor's failure to provide such special protection.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Conduit 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. Pull Boxes 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. Conduit or Pull Boxes 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 34 42 25**

### **SIGNAL FIBER NETWORK**

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

##### **1.01 SUMMARY**

- A. This section includes the material, equipment, installation, testing and management of a closed network for signal and crossing vital communications, using fiber optic cable as the physical medium.
- B. Traditional communications for vital signal and crossing communications on SCRRRA property utilize a combination of railroad track and copper cable as the physical medium.
- C. Station and non-vital train control communications requirements can be found in Section 34 44 25 - Fiber Optic Subsystem and Section 34 44 79 – Optical Wide Area Networks. These requirements are separate and distinct from the requirements of this Section.

##### **1.02 RELATED SECTIONS**

- A. Related Specification Sections include but are not limited to:
  - 1. Section 01 33 00 Submittal Procedure
  - 2. Section 34 42 00 General Signal Requirements
  - 3. Section 34 44 25 Fiber Optic Subsystem
  - 4. Section 34 42 38 Interlocking Controls
  - 5. Section 34 42 56 Signal Grounding
  - 6. Section 34 42 58 Signal System Testing
  - 7. Section 34 42 64 Highway-Rail Grade Crossing Warning Systems

##### **1.03 REFERENCES**

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA); Communications and Signals Manual of Recommended Practices (C&S Manual).
- B. ANSI/TIA-568.3-D Fiber Cabling and Components
- C. ANSI/ICEA S-87-640-2006, Standard for Fiber Optic Outside Plant Communications Cable
- D. ASTM E-814 - Standard Test Method for Fire Tests of Penetration Fire Stop Systems.
- E. International Organization of Standardization (ISO); 9001 Quality Management



Services.

- F. Railroad Administration (FRA), Code of Federal Regulations.
- G. United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 (PE-90), Specification for Filled Fiber Optic Cables
- H. GR-20-CORE, Generic Requirements for Optical Fiber and Optical Fiber Cable
- I. UL-969, Standard for Marking and Labeling Systems.

#### **1.04 SUBMITTALS**

- A. Submit under Section 01 33 00, Submittal Procedure.
- B. The Contractor shall refer to Section 34 42 00, General Signal Requirements for related and additional submittal requirements.
- C. The Contractor shall submit complete technical information for all products herein.
  - 1. For the proposed fiber optic cable, the Contractor shall submit cable manufacturer's qualifications if proposing an equivalent product. The Contractor shall include manufacturer's ISO 9001 Certification Number.
- D. The Contractor shall submit a list and quantity of spare equipment as detailed herein. Contractor is responsible for delivery of spare equipment to the SCRRA facility in Pomona, CA.
- E. Prior to ordering any signal fiber optic cable, the Contractor shall submit a Fiber Cable Order Plan that includes a complete listing of cable types, cable manufacturer(s), quantities, reel sizes and targeted location of installation within the project. The plan shall be inclusive of cable slack within the subsystem and shall include additional cable reels (amounting to 25% of total fiber cable required) to address any damage and repair that arises during construction.
- F. The Contractor shall submit Optical Link Calculations for all network links (signal and crossing) prior to procurement of SFP optics.
- G. Prior to signal fiber cable installation, the Contractor shall submit a Cable Installation Plan. The plan shall include a written cable installation procedure and supporting butterfly vault diagrams. This procedure shall be prepared based on Contractor's review of the conduit plans, survey of conduit and pull box locations in the field and shall include a cabling plan and installation information for each cable pull. The installation plan shall include butterfly vault diagrams for each pull box with detail for slack quantity, location of cable within the duct bank/vault, GPS coordinates of the vault and cable labeling. The installation plan shall include a spreadsheet of all cable labels proposed at each location (inside pull boxes and instrument enclosures). The installation plan shall include proper procedures for feeding cable into conduit to maintain proper bend radii, and to minimize friction. A cut sheet shall be submitted for the wire pulling lubricant.

- H. The Contractor shall submit a Signal Fiber Cable Test Procedure. Both TIA-560-C.0 Tier 1 (attenuation, link length and polarity) and TIA-560-C.0 Tier 2 (OTDR) testing are required for final acceptance. The cable link type is backbone and shall be tested at 1310nm and 1550nm wavelengths bi-directionally.
1. Included in the test procedure shall be test results summary sheet that contains the following information:
    - a. Link locations (from and to)
    - b. Fiber number
    - c. Cable length (feet and km)
    - d. Reported fiber attenuation at 1310nm and 1550nm
    - e. Connector loss budget
    - f. Number of splices within link
    - g. Splice loss budget
    - h. Total link loss (calculated)
    - i. Total link loss (measured 1310nm)
    - j. Total link loss (measured 1550nm)
  2. The test results summary will set the parameters for acceptance testing prior to making measurements in the field. This will facilitate the Contractor to understand the minimum acceptance criteria to allow for cleaning, retest measurements in the field during one mobilization. Test reports shall be submitted to the Engineer after installation and prior to placing cable in service.
  3. Additional test requirements are detailed herein.
- I. The Contractor shall submit a Signal Fiber Network Test Procedure. Minimum test requirements are detailed herein.
- J. The Contractor shall submit a Crossing Fiber Network Test Procedure. Minimum test requirements are detailed herein.
- K. The Contractor shall submit a proposed RSL910 switch typical configuration file for the signal and crossing networks. The Contractor shall hold four (4) configuration development meetings at two (2) hours each with Metrolink to determine the final switch configurations.
- L. The Contractor shall submit a Signal Fiber Network Training Plan for approval. Minimum training requirements are detailed herein.

## 1.05 QUALITY ASSURANCE

- A. Cable Manufacturer Pre-Qualification Requirements:
1. The Contractor shall obtain Resident Engineer's approval of cable manufacturer(s) and installer(s). The Contractor shall provide all data required and requested for Resident Engineer evaluation and shall make the arrangements for any required demonstrations and tests requested by the Resident Engineer at no additional cost to SCRRA.
  2. Past Performance and Experience: The Contractor proposed cable manufacturer(s) must demonstrate previous successful experience in supplying cable specified herein. A list of such installations shall be provided for each cable manufacturer to be considered.
  3. Technical Data: The Contractor shall provide full technical data that demonstrates compliance with the requirements of these Specifications for each specified cable type the Contractor plans to provide.
    - a. The proposed manufacturer(s) of cables, in accordance with the requirements of these technical specifications, shall have in place or implement, an effective quality assurance program adhering to the requirements of ISO 9001 to ensure purchase control performance.
    - b. The cable manufacturer(s) shall be ISO 9001 certified.
  4. Point of Origin: The cable shall be made in the United States of America.
  5. Warranty: The Contractor proposed manufacturer(s) shall warrant that the design, material, and workmanship incorporated in each item of cable shall be of the highest grade and consistent with the established, and generally accepted standards for railroad and transit applications; and that each such item and every part and component thereof shall comply with these Specifications. The fiber optic cable manufacturer shall warrant the fiber optic cable for 25 years.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Cleaning of Fiber Optic Connections
1. Any contamination in the fiber connection can cause failure of the component or of the system. Dust in the air can deposit on the connector. Other types of contamination include oils from human hands, film residues, powdery coatings left from evaporation.
  2. Contractor shall have tools to inspect and clean the fiber optic connectors every time a fiber connector is exposed to air:
    - a. Fiberscope for inspection, always while laser sources are off.
    - b. Dry cleaning by cartridge, pocket style cleaners, or lint free wipes (clean room quality) or swabs.

- c. Wet cleaning by lint free wipes or swabs with 99% isopropyl alcohol.

B. Fiber Optic Cable

1. Safety:

- a. Never look directly into the end of a fiber that may be carrying laser light. Laser light can be invisible (undetectable by the eye) and can cause permanent eye damage.
- b. Cleaved or broken glass fibers are sharp and can pierce the skin easily, causing injury. Utilize tweezers to pick up cleave or broken pieces of glass fibers and then on a loop of tape kept for disposal.

2. Packing:

- a. The manufacturer(s) and/or vendor(s) shall ship cable on non-returnable wooden reels. Cable shall be shipped on reels substantial to withstand reasonable handling and shall be so designed that the inner end of the cable be accessible but protected from injury. All ends of the cable shall be sealed to prevent entrance of moisture and securely fastened to prevent them from becoming loose during transit. The top and bottom ends of the cable shall be available for testing. Resident Engineer or designate may inspect cable reels or storage area upon request.

3. Required Cable Reel Characteristics and Information:

- a. Weather resistance reel tag attached identifying the reel and cable.
- b. The manufacturer's identification and cable type.
- c. Part number of the cable.
- d. Cable identification number, which is referenced to the test sheet.
- e. Length of Cable.
- f. Gross weight.
- g. Contract name and number.
- h. Date of manufacture.
- i. Copy of the factory test attenuation results at 1310nm and 1550nm. Date cable was tested.
- j. The reel shall contain an arrow showing the direction in which the drum should be rolled to gain access to the cable.

- k. All ends of the cable shall be sealed to prevent entrance of moisture.
  - l. Test tails shall be at least two meters long.
4. Cables shall be inspected by Contractor at time of delivery to the construction site to assure that no damage was done in shipping and that the specified cable was received. Every reel shall be inspected by Contractor for physical damage, such as nails driven into reels, to secure shipping blocks, lagging, reel covering missing, or cable and seals missing or damaged. Each reel shall be 100% attenuation tested at 1310 nm and 1550 nm at time of delivery and submitted to the Engineer. All damaged or rejected cable shall be replaced promptly by Contractor at no cost to SCRRRA.
  5. Cables shall be stored at the construction site on solid surfaces, which shall adequately support the cable reels, but shall be well drained and not allow accumulation of liquids, oils, or chemicals.
  6. The cable reels shall be aligned, and protection provided so as not to allow the reel flanges to damage other reels. Adequate aisles and barricades shall provide accessibility but prevent construction equipment from damaging the cable reels.
  7. Cable ends shall be resealed promptly when a length is cut from the reel. Cable reels shall be properly handled by following the manufacturer's fork lift handling illustration that comes with the reel.
  8. Handling: Cable drums shall be complete with close fitting wooden battens to prevent damage to the cable during transit and storage.
  9. Acceptance at Site: Drums shall be examined at Contractor's local site depot for external damage. Damaged cables will not be accepted. All test results shall be provided to the Resident Engineer. The Resident Engineer retains the right to inspect Contractor's storage facilities.
  10. Storage and Protection: Drums shall be stored with flanges upright. Cable on drums with batten in place will be stored indoors.

## **PART 2 - PRODUCTS**

### **2.01 SIGNAL FIBER OPTIC CABLE (ARMORED)**

- A. The application of the signal fiber optic cable shall be as follows:
  1. One 24 strand signal fiber optic armored cable shall run continuously along the right of way as designated within the main conduit duct bank. This cable, defined as "FS24-1" on the Contract Drawings shall be referenced as "Signal Fiber Main" throughout the system. This cable shall be spliced in fiber pull boxes to lateral cables to enter the instrument enclosures.

2. One 24 strand signal loopback fiber optic armored cable shall run continuously along the right of way as designated within the main conduit duct bank. This cable defined as "FS24-2" on the Contract Drawings shall be referenced as "Signal Fiber Loopback" throughout the system. This cable purpose is for redundancy. This FS24-2 cable shall be spliced only at reel-to-reel ends or spliced to lateral cables at the project ends for termination/OTDR purposes.
  3. Within the FS24-1 and FS24-2 signal fiber optic cable:
    - a. The blue buffer tube, fibers 1-12, shall be designated for signal applications.
    - b. The orange buffer tube, fibers 13-24, shall be designated for crossing applications.
  4. One 24 strand fiber optic armored cable shall be used for lateral access to instrument enclosures, splicing to FS24-1. These lateral access cables shall be defined as "FS24LS" (lateral cable for signal application) or "FS24LX" (lateral cable for crossing application).
  5. Within the FS24LS and FS24LX signal fiber optic cable:
    - a. The blue buffer tube, fibers 1-12, shall be designated for railroad west adjacent locations.
    - b. The orange buffer tube, fibers 13-24, shall be designated for railroad east adjacent locations.
    - c. Refer to the Vital Fiber Network plans in the Contract Drawings to determine railroad east and west locations. Contractor shall note that railroad east and west are not necessarily the same as geographic east and west.
- B. The signal fiber optic armored cable shall be loose tube, gel-free, single jacket, single armored and contain 24 fiber optic strands. The signal fiber optic armored cable shall be Corning Altos Lite model number 024EUC-T4101D20 or approved equivalent. The cable shall be an accepted product of the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 (PE-90).
- C. Outdoor Cable Construction:
1. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the loose buffer tube shall be 2.5mm. The buffer tube shall be polyethylene.
  2. Each buffer tube shall contain 12 fibers. Buffer tubes shall be resistant to external forces and shall be meet the buffer tube cold bend and shrink back requirements of 7 CFR 1755.900.
  3. The fiber shall not adhere to the inside of the buffer tube.

4. Each fiber and each buffer tube shall be distinguishable by means of color coding in accordance with TIA-598 "Optical Fiber Cable Color Coding". The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color coded buffered fibers shall not adhere to one another.
5. The fibers shall be colored with ultraviolet (UV) curable links.
6. Fillers may be included in the cable core to lend symmetry to the cable cross section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. Fillers shall be nominally 2.5mm in outer diameter.
7. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be overcoated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.
8. Each buffer tube shall be gel-free. Each buffer tube shall contain water blocking material embedded in the inside wall of the buffer tube for water blocking protection. The water blocking material shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt or foreign matter. This material will preclude the need for other water blocking materials such as gels, yarns, foams or tapes.
9. The optical fibers shall not require cleaning before placement into a splice tray.
10. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process.
11. Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. Water blocking elements shall be applied uniformly throughout the buffer tube.
12. Two polyester yarn binders shall be applied contra helically with sufficient tension to secure the buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage. A water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. A water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.
13. Two ripcords shall be under the steel armor for easy sheath removal.
14. All tensile strength shall be provided by the central member.
15. An armor layer shall be applied directly over the cable core and water swellable tape. The armor shall be a corrugated steel tape, plastic-

coated on both sides for corrosion resistance, and shall be applied around the cable core and water swellable tape with an overlapping seam with the corrugations in register. The outer jacket shall be applied over the corrugated steel tape armor. The outer jacket shall be polyethylene with a nominal jacket thickness of 1.3mm. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall promote the growth of fungus.

16. The polyethylene jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.
17. The jacket or sheath shall be free of holes, splits and blisters.
18. The cable jacket shall contain no metal elements and shall be of a consistent thickness.
19. The maximum pulling tension shall be 2700 N (600 lbf) during installation and 890 N (200lbf) installed.
20. The minimum bend radius shall be 15 times the cable outside diameter while under tension and 10 times the cable outside diameter installed.
21. The shipping, storage, and operating temperature range of the cable shall be -40 degrees C to +70 degrees C. The installation temperature range of the cable shall be -30 degrees C to +70 degrees C.

D. Cable Identification

1. The cable jacket shall be marked with the manufacturer's name, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket.

E. Cable Performance Specifications

1. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation at extreme operational temperatures (-40 degrees C and +70 degrees C) shall not exceed 0.15 dB/km at 1550 nm for single-mode fiber.
2. When tested in accordance with FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable," a one-meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.
3. When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 70 degrees C.
4. When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," the cable shall withstand a minimum



compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

5. When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.
6. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," except that the number of cycles shall be two at three locations along a one meter cable length and the impact energy shall be at least 4.4 Nm (in accordance with ICEA S-87-640)", the change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.
7. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670N (601 lbf) and residual load of 30% of the rated installation load. The axial fiber strain shall be  $\leq 60\%$  of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load. The axial fiber strain shall be  $\leq 20\%$  of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.15 dB at 1550 nm for single mode fiber.
8. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.
9. When tested in accordance with FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 55 kA without loss of fiber continuity. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15  $\mu$ S (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half-value of the waveform envelope shall be from 40 to 70  $\mu$ S.

10. When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable," the cable shall withstand four full turns around a mandrel of  $\leq 20$  times the cable diameter after conditioning for four hours at test temperatures of  $-30$  degrees C and  $+60$  degrees C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or other openings. The change in attenuation shall not exceed 0.30 dB at 1550 nm for single mode fiber.

## **2.02 HARDWARE GROUNDING KIT FOR ARMORED CABLES**

- A. All armored fiber optic cable shall be bonded and grounded for the safe and effective dissipation of unwanted electrical current and to promote personnel and site safety in accordance with NEC Articles 770.93 and 770.100. The armored fiber optic cable shall utilize the kits at point of access within the fiber splice enclosure within the pull box, and within the fiber distribution panel within instrument enclosures. These points shall be tied to the instrument enclosure ground buss.
- B. The hardware grounding kit utilized within fiber splice enclosure shall be Corning HDWR-GRND-KIT or approved equivalent. Grounding shall use green #6 AWG stranded copper.
- C. The hardware grounding kit for the fiber distribution panel shall be Corning FDC-CABLE-GRND or approved equivalent.
- D. Bonding is the permanent connection of metallic parts to form an electrical path that will be conductive and continuous. This is required for underground tracing/location of fiber optic cable once installed.
- E. Grounding is the act of connecting an electrical path to the earth of some conducting body that serves as the earth. Effective ground is bonded to a grounded neutral conductor or to a grounding system designed to minimize hazard to personnel and having resistance to ground low enough to permit prompt operation of circuit protection devices.

## **2.03 FIBER SPLICE ENCLOSURE (FSE)**

- A. The fiber splice enclosure utilized in pull boxes for the signal fiber and the signal loopback fiber shall be Coyote Pup Closure, 8006661, by Preformed Line Products or approved equivalent.
- B. The fiber splice tray shall be compatible with the Coyote Pup Closure, 80806033, by Preformed Products or approved equivalent. The splice tray shall support 12 fusion splices.
- C. Additional accessories and installation materials include mounting brackets, sealing materials, port plugs and fusion splice materials.
- D. At all times, a separate fiber splice enclosure shall be used for each cable type when splices are required. Cable types subject to this criterion include: signal fiber main, signal fiber loopback, and communications fiber.

- E. The fiber splice enclosure shall have the following characteristics:
1. A six (6) port end plate
  2. A size that does not exceed 20" L x 10" W x 8" H.
  3. Suitable for loose tube fiber and below grade installation applications
  4. Includes mounting hardware for pull box vertical (side) wall.
  5. Contains a permanent neoprene gasket system requiring no re-entry kits.
  6. Contains integrated air valve to confirm integrity of final assembly.
  7. RDUP Listed (RUS)
  8. Meets or exceeds the test requirements of Telecordia GR-771 CORE.

#### **2.04 FIBER DISTRIBUTION PANEL (FDP)**

- A. The fiber distribution panel utilized in instrument enclosures shall be Wall Mountable Connector Housing (WCH), Corning WCH-02P and WCH-04P, or approved equivalent.
1. WCH-02P shall be utilized in instrument enclosures that require two (2) cassettes per the Contract Drawings. This will terminate the lateral cables for signal fiber main cable (FS24-1) only.
  2. WCH-04P shall be utilized in instrument enclosures that require four (4) cassettes per the Contract Drawings. This will terminate the lateral cables for signal fiber main (FS24-1) and the signal fiber loopback (FS24-2).
- B. At all times, a separate FDP shall be used within the instrument enclosure for each cable application when terminations are required. Cable applications subject to this criterion include lateral fiber cables for signal (FS24LS), lateral fiber cables for crossing (FS24LX), and communication fiber cables.
- C. The fiber distribution panel shall have the following characteristics:
1. Wall mountable.
  2. Capable of interconnect and cross-connect.
  3. Accepts Closet Connector Housing (CCH) cassettes.
  4. Lockable transparent jumper side door.
  5. Removable strain relief bracket.
  6. Segregated cable and fiber slack routing.
  7. Preinstalled bubble level to assist installation.

8. Complaint with RoHS 2011/65/EU.
- D. The fiber distribution panel shall utilize splice cassette Corning CCH-CS12-3C-P00RE or approved equivalent.
  1. The Splice cassette shall have the following characteristics:
    - a. Supports 12 fibers, single fiber splicing.
    - b. Contains factory terminated pigtails.
    - c. Utilizes single mode OS2 250um fiber, SC Simplex UPC connectors, with a blue housing color.
    - d. Cassettes shall be preloaded and pre-routed for quick fusion splicing.

## **2.05 OPTICAL FIBER PATCH CORDS FOR SIGNAL AND CROSSING NETWORKS**

- A. Patch cords shall be utilized to connect the FDP to the Ethernet Switch or to bypass a location by making an FDP to FDP connection. This may be required at various stages of commissioning.
  1. SC to LC Duplex, Corning part number 045802R512000xM, or approved equivalent. (replace x with desired length in meters)
  2. SC to SC, Corning part number 585802G512000xM, or approved equivalent. (replace x with desired length in meters)
- B. Patch cords shall meet the following characteristics:
  1. Zipcord tight-buffered cable colored yellow
  2. Typical insertion loss 0.15dB
  3. Suitable for general building applications
  4. Ceramic ferrule and UPC polish
  5. All patch cords shall be factory made and tested. Connectors shall not be field assembled.

## **2.06 ETHERNET SWITCH FOR VITAL COMMUNICATIONS**

- A. The Contractor shall provide an industrially hardened Ethernet switch to interface with the ElectrologIXS VLC VPM-3 for vital communications between signal or crossing locations. The unit shall be Siemens supplied RUGGEDCOM RSL910, Part number 6GK6491-0LB00-2AN1 or approved equivalent.
  1. A distinct ring network shall include all locations that utilize a signal application.
  2. A distinct ring network shall include all locations that utilize a crossing

application.

3. The switch quantities for each location or installation shall be as shown in the Contract Drawings.

B. The Ethernet switch shall have the following characteristics:

1. Fully managed with Ethernet over Very high bit rate Digital Subscriber Line 2 (EoVDSL2) capabilities.
2. The switch shall be designed to operate reliably in electrically and climatically harsh and demanding environments typically encountered in Metrolink operations.
3. The switch shall be equipped with six (6) copper Fast Ethernet ports (10/100Base-Tx); two (2) Gigabit Ethernet Small Form-factor Pluggable (SFP) uplink ports (1000Base-Lx); and two (2) EoVDSL2 ports with terminal blocks.
4. Operation at 12VDC, from -40 degrees C to +85 degrees C with no fans.
5. Conformal coated printed circuit boards.
6. 20 AWG galvanized steel enclosure.
7. IP40 ingress protection.
8. Panel mounting kit.
9. The user shall be able to configure the switch as either primary or secondary (master or slave) when EoVDSL is utilized.
10. Power indication Light Emitting Diode (LED).
11. Alarm indication LED.
12. RS232 port (Universal Serial Bus or USB Type-B and serial).
13. Failsafe alarm relay.
14. Solid green LED to indicate established link.
15. Blinking LED to indicate data transmission activity.

C. The Ethernet switch shall utilize single mode SFP optics. The Contractor shall determine optics at each location by performing fiber link calculations that provide a minimum of 6dB system margin. As determined by the fiber link calculations and system margin criteria, the SFP transceivers shall be selectable from:

1. Siemens RUGGEDCOM SFP1132-1LX10, part number 6GK6000-8FG52-0AA0 (with nominal distance of 10 km).

2. Siemens RUGGEDCOM SFP1132-1LX25, part number 6GK6000-8FG53-0AA0 (with nominal distance of 25 km).

## 2.07 OPTICAL TEST AND REPAIR EQUIPMENT

- A. The Contactor shall deliver to SCRRA the following optical test and repair equipment to support the signal fiber network.
- B. OTDR and Inspection Meter
  1. The OTDR, OTLS and Inspection Meter shall be Fluke OFP2-CFP-QI or approved equivalent with the following features and elements:
    - a. Single mode fiber support
    - b. SC/LC adapters and launch cables
    - c. Cleaning kits
    - d. Fiber inspection video probe
    - e. Mainframe and remote units
    - f. OTDR module
    - g. OLTS module
    - h. Integrated Wi-Fi
    - i. AC charger
    - j. Statement of calibration
  2. A hardened case, Fluke VERSIV-CASE3 or approved equivalent
- C. Fusion Splicer
  1. The fusion splicer shall be FiberFox America Mini 6S or approved equivalent:
    - a. The fusion splicer shall be a single fiber fusion splicer with an LCD monitor and touch screen.
    - b. The fusion splicer shall utilize a core alignment with 300 power X/Y magnification.
    - c. The fusion splicer shall have a 16 second heating time and a 12 second splicing time.
    - d. The fusion splicer shall include a thermal stripper, precision cleaver, and two (2) batteries.
    - e. The average splice loss for single mode shall be 0.02dB.

**2.08 SPARE EQUIPMENT**

- A. The Contractor shall deliver to SCRRA the following spare equipment to support the signal fiber network.
  - 1. Six (6) Underground Fiber Splice Enclosures
  - 2. Six (6) Ethernet Switches for Vital Communications
  - 3. Twenty (20) SC-SC Optical Patch Cords (2m length)
  - 4. Twenty (20) SC-LC Optical Patch Cords (2m length)
  - 5. Six (6) SFP optics, 10km range
  - 6. Two (2) SFP optics, 25km range

**PART 3 - EXECUTION****3.01 INSTALLATION**

- A. Signal Fiber Cable
  - 1. Cables shall be tested by the Contractor at time of delivery to the construction site to assure that no damage was done in shipping and that the specified cable was received. All damaged or rejected cable shall be replaced promptly by the Contractor at no additional cost to SCRRA.
  - 2. Cable installation shall be accomplished in accordance with the Resident Engineer approved Site Specific Work Plan and Cable Installation Plan. These plans shall incorporate manufacturer's installation recommendations and industry best practices. Contractor shall provide any installation hardware necessary to route, support, terminate, or protect any cable installation.
  - 3. Contractor shall be responsible for verifying the required cable length for each cable run prior to installation. Plans may be used for defining locations and estimating cable lengths. However, no Plans shall be used to determine final lengths and cuts. Actual lengths shall be determined by the Contractor making on-site inspections and measurements.
  - 4. Cable pulling locations shall be selected to protect the cable on the reel and in slack loops. The Contractor shall be responsible for protecting cable after working hours where cable installation is not completed during a single shift.
  - 5. Any damage to the SCRRA signal fiber cable shall be reported to the Resident Engineer immediately, whether prior to installation, during installation, during other construction, or during test or observation after installation. Cable damage due to Contractor negligence shall be replaced and repaired by the Contractor at no additional cost to SCRRA.

- a. If damage occurs, the method of repair or correction of the damage shall be submitted for written approval from the Engineer. The Contractor shall submit the proposed repair plan to make repairs of proposed correction action promptly. OTDR testing of existing damage shall be submitted as part of the repair proposal.
  6. Wire Pulling Lubricant shall be used to reduce tension on the cable during the installation process. The lubricant shall be compatible with the cable sheath and not cause damage to the cable.
  7. When a winch or pulling machine is used during installation, the Contractor shall provide a dynamometer and the dynamometer shall be used to monitor the tension on the cable. The dynamometer shall be certified as calibrated and shall hold the peak value of the cable pull. The peak value shall be recorded and forwarded to the Resident Engineer as part of the installation test data submittals.
  8. The Contractor shall provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions such as movement, vibration or sharp corners on equipment. To prevent water from entering the cable, protect bare cable ends by placing a cable cap, followed by several wraps of tape around the cap.
  9. The Contractor shall not exceed the cable's minimum bend radius for cable under any condition, including but not limited to, under tension or long-term installation/storage.
  10. Continuity of cable shall be maintained between termination or splice locations shown on the Plans. Additional splices shall not be allowed without the prior written Resident Engineer approval.
  11. All cable entrance openings in equipment enclosures, houses, rooms and junction boxes shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compounds for rooms, houses, walls, or other partitions shall be fire retardant per ASTM E814. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit, pipe, or duct bank. All spare conduits shall be sealed.
- B. Signal Fiber Cable Slack Storage
1. All pull boxes that contain the signal fiber cable and signal loopback fiber cable shall be each coiled to provide a service loop (slack) of 150 feet.
  2. In areas where the signal fiber cable or signal loopback fiber cable utilize a fiber splice enclosure, the service loop (slack) shall provide 75 feet of slack to support each side/direction of the fiber splice enclosure.
  3. The signal and crossing lateral cable shall provide a service loop (slack) of 75 feet.
  4. Slack requirements are detailed in the Contract Drawings.



- C. Hardware Grounding Kit for Armored Cables
1. The Hardware Grounding Kit shall be installed in accordance with manufacturer recommendations.
  2. The Ground Bus shall be installed in pull boxes to provide a close disconnect for the ground wire when a FSE needs to be removed for servicing and to prevent multiple FSEs from being physically tied together by the ground wire. Additional detail is shown in the Contract Drawings.
- D. Fiber Splice Enclosure (FSE)
1. The FSE shall be installed in accordance with manufacturer recommendations.
  2. All fiber cables shall be clearly labeled for identification at the point leaving the FSE and before entering the duct bank conduit. Refer to labeling requirements herein for additional detail.
  3. All fiber optic splices shall be fusion splices with a splicer equipped with Local Injection and Detection (LID). The loss across each spliced fiber shall be less than or equal to 0.10dB. Utilize proper fiber cleaning procedures.
  4. Clean shells and end plates to remove sand, dirt and other foreign substances.
  5. Lubricate the neoprene gasket in the shells with a uniform thin layer to assure assembly and reentry.
  6. Any shell that is damaged shall be replaced.
  7. Using the air valve, complete a flash test with a soap and water solution to a maximum of 10 PSI to determine that the enclosure is properly sealed. Confirm the pressure with a pressure gauge. Apply the soap/water solution to all sealed surfaces of the enclosure. Visually inspect that bubbles are not present, which indicate that the enclosure is not properly sealed. At the end of the flash test, release the pressure and reinstall the valve cap.
  8. Mount the FSE to the pull box vertical wall to keep the enclosure off the ground.
- E. Fiber Distribution Panel (FDP)
1. The FDP shall be installed in accordance with manufacturer recommendations.
  2. All fiber cables shall be clearly labeled for identification at the point entering the FDP and before leaving the signal enclosure conduit. Refer to labeling requirements herein for details.

3. Additional labels shall be applied to the FDP outside main door with identification of "SIGNAL" or "CROSSING" in large font, reflecting the FDP application. Labels shall also be placed on the panel door indicating FDP Card Letter and the adjacent railroad west or railroad east location within the network. An example of this convention for the Signal FDP at location CP Stuart is "A: 7<sup>TH</sup> Street" and "B: Church Street".
  4. The central strength member of the cable shall be attached to the FDP for strain relief. The outer jacket of the cable shall be attached to the FDP with a cable clamp.
  5. All fiber optic splices shall be fusion splices with a splicer equipped with Local Injection and Detection (LID). The loss across each spliced fiber shall be less than or equal to 0.10dB. Utilize proper fiber cleaning procedures.
  6. Utilize blank adapter panels to prevent dust entry for any unused slots.
- F. Ethernet Switch for Vital Communications
1. The Ethernet Switch shall be installed in accordance with manufacturer recommendations.
  2. The Ethernet Switch shall be panel mounted.
  3. Utilize #16AWG copper wire for terminal block power.
  4. Connect the failsafe alarm relay to the ElectrologIXS VLC. Utilize the normally open wiring.

### 3.02 LABELS AND TAGGING

- A. Install cable identification tags at both ends of each cable, at the entrance and the exit of each pull box, housing, or fiber splice enclosure. All labels shall be machine printed.
- B. All signal fiber optic cable labels shall utilize an orange colored 2" x 3.5" self-laminating fiber optic cable tag made of rigid PVC material and a polyester self-sealing cover. The orange tag shall be resistance to moisture and grease. The orange tag shall have slotted holes to accept the ties for a secure mounting application. The orange tag shall be pre-printed "Caution Fiber Optic Cable".
- C. On the orange tag, under the cover, a white color industrial vinyl tape shall be applied. The vinyl tape shall use a permanent acrylic adhesive and contain a topcoat for thermal transfer printing. The following labels shall be printed on the vinyl tape in accordance with the Contract Drawings:
  1. Label "T1"
    - a. Application: Pull box, Signal Fiber Main Cable
    - b. Template: SIGNAL FIBER

SG<Signal Fiber Segment Number>

c. Example: SIGNAL FIBER

SG200

2. Label "T2"

a. Application: Pull box, Signal Fiber Loopback Cable

b. Template: SIGNAL LOOPBACK

SGL<Signal Loopback Fiber Segment Number>

c. Example: SIGNAL LOOPBACK

SGL200

3. Label "T3"

a. Application: Pull box, Signal Fiber Lateral Cable

b. Template: SGV<Vault Milepost>-FSE-FS24-SG<Segment Number>-LS /

CP<CP Milepost>-FDPSIGNAL

c. Example: SGV66.45-FSE-FS24-SG202-LS /

CP66.45-FDPSIGNAL

4. Label "T4"

a. Application: Pull box, Crossing Fiber Lateral Cable

b. Template: SGV<Vault Milepost>-FSE-FS24-SG<Segment Number>-LX /

CP<CP Milepost>-FDPXING

c. Example: SGV66.45-FSE-FS24-SG202-LX /

CP66.45-FDPXING

5. Label "T5"

a. Application: Instrument Enclosure, Signal Fiber Lateral Cable

b. Template: CP<CP Milepost>-FDPS-FS24-SG<Segment Number>-LS /

SGV<Vault Milepost>-FSE-1

c. Example: CP66.45-FDPS-FS24-SG202-LS /

## SGV66.45-FSE-1

6. Label "T6"
  - a. Application: Instrument Enclosure, Crossing Fiber Lateral Cable
  - b. Template: CP<CP Milepost>-FDPX-FS24-SG<Segment Number>-LX /

## SGV&lt;Vault Milepost&gt;-FSE-2

- c. Example: CP66.45-FDPX-FS24-SG202-LX /

## SGV66.45-FSE-2

- D. The fiber installation plan shall include a spreadsheet of all cable labels proposed at each location (inside pull boxes and instrument enclosures) for Engineer approval.

**3.03 FIBER TESTING**

- A. All cables shall be OTDR tested at 1310 nm and 1550 nm for single mode operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connection insertion loss.
- B. All dark fibers shall be OTDR tested. Dark fiber that is not terminated at an FDP or spliced through but instead left coiled within the splice tray or splice case shall be bare fiber OTDR tested. SCRRA shall have a complete test record of all fiber installed, whether it is used in the design or not.
- C. OTDR tests shall be performed utilizing a pulse suppressor such that the FDP termination shall be shown.
- D. All fibers shall be tested in both directions.
- E. A launch cable shall be installed between the OTDR and first link connection. A receive cable shall be installed after the last link connection.
- F. Optical Return Loss (ORL) for each link shall be measured.
- G. Test limits
  1. Reflective events shall not exceed -40dB
  2. Connections shall not exceed 0.15dB of attenuation
  3. Non-reflective events (splices) shall not exceed 0.2dB
  4. Point discontinuities shall not exceed 0.1dB
  5. ORL shall be less than -30dB
- H. Test Information Required

1. Site/link identification
2. Fiber Number identification
3. Pass/Fail evaluation (with correct test limits applied)
4. Name of the standard selected to execute the stored test results.
5. Cable type and value of the "index of refraction" used for length calculations.
6. Date and time the test results were saved in the memory of the tester.
7. Brand name, model, serial number and calibration data of the tester.
8. Insertion loss measured at each wavelength, the test limit calculated for the corresponding wavelength and the margin (difference between the measured attenuation and the test limit value).

### 3.04 NETWORK TESTING

- A. Contractor shall present to the Resident Engineer for approval a Signal Fiber Network Test Plan showing the tests to be made, format and layout of test forms and reports, and the limiting values to be used, at least 60 days in advance of the testing.
- B. Signal Network Test Requirements
  1. The Contractor shall perform all manufacturer's recommended local and system equipment testing.
  2. Each node and link of the Gigabit Ethernet Signal Network ring shall be tested for connectivity, throughput and redundancy are part of the larger network. This testing shall include but not be limited to the following:
    - a. Verification of 6dB link margin with maximum throughput (99% packet transmission or better) across each optical link for a minimum test duration of five (5) minutes.
    - b. Verification of transmission between copper ports with maximum throughput (99% packet transmission or better) for a minimum test duration of two (2) minutes. All copper ports shall be tested.
    - c. Record the optical link software values of all SFPs and produce a spreadsheet comparing the link values to the link margin. Provide explanation for any discrepancies.
    - d. Record failover time during a protective switch by disabling the SFP transmitted via software during maximum throughput transmission for a link.
  3. When all testing is completed satisfactorily and prior to cutover, verification is to be made to ensure the entire network is operational and

in good health.

4. Cutover testing shall be integrated into signal testing.
  - a. Verification shall be made to ensure that when each fiber patch cord is disconnected, the failsafe alarm relay produces an indication on the Local Control Panel Screen and Metrolink Dispatcher's Screen.
  - b. Verification shall be made to ensure that with the loopback portion of the network operational, when each fiber patch cord is disconnected on a network switch, all vital remote links remain healthy, and the signal system remains active.
  - c. Verification shall be made to ensure that with the loopback portion of the network disabled, when each fiber patch cord is disconnected on a network switch, the appropriate vital remote links fail.

C. Crossing Network Test Requirements

1. The Contractor shall perform all manufacturer's recommended local and system equipment testing.
2. Each node and link of the Gigabit Ethernet Crossing Network ring shall be tested for connectivity, throughput and redundancy are part of the larger network. This testing shall include but not be limited to the following:
  - a. Verification of 6dB link margin with maximum throughput (99% packet transmission or better) across each optical link for a minimum test duration of five (5) minutes.
  - b. Verification of transmission between copper ports with maximum throughput (99% packet transmission or better) for a minimum test duration of two (2) minutes. All copper ports shall be tested.
  - c. Record the optical link software values of all SFPs and produce a spreadsheet comparing the link values to the link margin. Provide explanation for any discrepancies.
  - d. Record failover time during a protective switch by disabling the SFP transmitted via software during maximum throughput transmission for a link.
3. When all testing is completed satisfactorily and prior to cutover, the Contractor shall disable all ports on the Ethernet switch that support local area devices including unused ports. During cutover, each port shall be remotely enabled, one port at a time to cutover services incrementally and observe network health.
4. Cutover testing shall be integrated into crossing testing.

- a. Verification shall be made to ensure that when each fiber patch cord is disconnected, the failsafe alarm relay produces an indication on the Local Control Panel Screen.
  - b. Verification shall be made to ensure that with the loopback portion of the network operational, when each fiber patch cord is disconnected on a network switch, all vital remote links remain healthy, and the Crossing system remains active.
  - c. Verification shall be made to ensure that with the loopback portion of the network disabled, when each fiber patch cord is disconnected on a network switch, the appropriate vital remote links fail.
- D. Contractor shall become familiar with and comply with SCRRRA safety rules as to safe operation of construction equipment and trains and the protection of personnel. All safety precautions shall be observed, and any required safety procedures shall be followed.
- E. The Contractor shall provide all calibrated instruments, materials and labor required for tests specified.

### **3.05 SIGNAL FIBER NETWORK TRAINING**

- A. The contractor shall provide a comprehensive training program for the signal fiber network including the following:
- 1. Passive elements (2 classes, 8 hours)
    - a. Physical fiber configuration, equipment layouts and labeling
    - b. Usage of fiber test and repair equipment
    - c. Maintenance best practices
    - d. Includes lab time with test and repair equipment
  - 2. Site walk (2 classes, 4 hours)
    - a. View pull box, duct bank and equipment layouts
  - 3. Active elements (2 classes, 8 hours)
    - a. Logical signal network configuration, switch configuration and alarms
    - b. Logical crossing network configuration, switch configuration and alarms
    - c. Maintenance best practices
    - d. Includes lab time using spare Ethernet switch equipment

- B. Training plan
  - 1. The Contractor shall submit a training plan that outlines the proposed training. Coordination and flexibility with SCRRA availability shall be required.
    - a. The passive and active element training shall be located at SCRRA's Pomona, CA location. The site walk will be held at a proposed easily accessible location on the project property.
    - b. Each training class shall allow up to eight (8) SCRRA individuals to attend. Contractor shall submit six (6) proposed training dates that are not consecutive.
    - c. The resume of each trainer shall be submitted for approval. The trainer shall be knowledgeable and qualified to teach each area of training. Multiple trainer resumes shall be submitted if needed.
    - d. Each training class shall include paper handouts and all materials on a thumb drive for each student.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Signal Fiber Network 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. Signal Fiber Network 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 34 42 38**  
**INTERLOCKING CONTROL**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This section includes requirements for installing, testing, and documenting vital microprocessor based interlocking controller racks, custom local control panels (CLCP), and ATCS compliant data radio that provides the functionality shown on the Contract Plans and described here in.
- B. Final application logic programs, including EPROMS, will be furnished by the Engineer.
- C. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 34 42 40 – Solid-State Coded Track Circuits
  - 2. Section 34 42 58 – Signal Systems Testing

**1.02 REFERENCES**

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
  - 1. Part 236 - Rules, Standards, and Instructions for Railroad Signal System.
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- C. Southern California Regional Rail Authority (Metrolink) Engineering Standards

**1.03 SUBMITTALS**

- A. Submit a narrative explanation of the electrical and/or mechanical methods of configuration control used to ensure that the application logic software installed is the correct software for the specific location and that it is the latest version. It shall explain Contractor's procedures for handling components of the vital interlocking controller.
- B. Submit certified acceptance reports.
- C. Submit five (5) copies of all test reports and verification of tests in accordance with the approved testing plan.
- D. Submit five (5) copies of Shop Drawings for each CLCP faceplate design being provided for approval of the Resident Engineer.

- E. Submit a narrative explanation of Interlocking Controls changes sixty (60) in advance of any modifications, removals or additions. The narrative shall detail critical feature changes and provide checksum and CRCs of any application program changes. These changes include both vital application and Positive Train Control (PTC) Map file changes.
- F. Rack testing of the application software. Rack testing shall mean the software has been thoroughly tested and all possible conditions simulated using the same type of Interlocking Control equipment and executive software being provided under this contract.

#### **1.04 QUALITY ASSURANCE**

- A. Install, configure, and test the interlocking controller and custom local control panel (CLCP) to conform to the requirements of CFR 49, Part 236, AREMA C&S Manual Parts 2.2.10 and 8.1.2 and the manufacturer's instructions.
- B. Perform operational testing of the equipment in accordance with the requirements specified in 34 42 58, Signal System Testing.
- C. All Interlocking Controls furnished under this Work shall be equipped with a PTC Wayside Interface Unit (WIU) and be compatible with the existing Metrolink PTC network. Interlocking Controls shall not require any additional interfacing equipment beyond what Metrolink currently uses.
- D. Contractor furnished software and components shall be new, manufacturer certified, and the latest SCRRRA approved version.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Package plug in modules for shipment separately from their card cage units using ESD safe packaging. Protect each item from damage or loss during handling and shipment.
- B. Clearly identify each controller unit, LCP, and their associated components on the packing crate, referencing its intended location.

#### **1.06 WARRANTY**

- A. Provide warranty from defects for two (2) years from the first date of final acceptance.

### **PART 2 - PRODUCTS**

#### **2.01 MATERIALS**

- A. Solid State Microprocessor Interlocking Controller.
  - 1. Controller shall be an ElectrologIXS Vital Logic Controller (VLC) manufactured by ALSTOM.

2. The interlocking controller shall be capable of operating 12 VDC vital and non-vital relays. A minimum of 8 vital inputs and six (6) vital outputs shall be grouped on a single I/O module.
3. The vital lamp driver module provided to operate wayside signal lamps shall be capable of directly driving a minimum of 16 each 10 VDC, 18 watt or 25 watt lamps through isolated lamp driver outputs for on, off, and flashing. Flashing shall be at a nominal rate of 55 flashes per minute. Controller shall provide tumble - down indications based upon light out detection using both hot and cold filament checking.
4. Controller chassis shall be designed to house a minimum of nine (9) modules. Three (3) slots shall be reserved for modules that control and process vital and non-vital application logic and communications. The remaining slots shall be designed to house any user defined configuration of input/output, lamp driver, and operating modules.
5. Plug connectors shall be keyed for each module type to ensure only the proper module can be connected.
6. The interlocking controller shall have the capacity to directly connect, via a cable, to a chassis that will generate and receive Electro Code 4 and Electro Code 5 track codes without use of relay interfacing.
7. The interlocking controller must be capable passing vital data, via a serial connection, to existing VHLC units utilized on SCRRRA properties.
8. The software associated with assuring the vitality of the system shall be an inherent part of the basic controller system and shall not be accessible for modification by the user. Changes to the application logic installed in the system shall not require re-verification of the software associated with assuring system vitality. The application logic shall be protected so that it is user modifiable by authorized personnel only.
9. The program compiler used in developing the site-specific application logic software shall be designed to allow the user to construct individual equation logic equations utilizing "ladder-logic" display elements. Reports generated by the compiler shall provide the user with a complete and detailed description of the system configuration including, but not limited to, module location assignments, internal timer settings, auxiliary input/output assignments, vital lamp output assignments, CTC control and indication bit assignments, electronic track code circuit assignments, data recorder equation selection, remote input/output assignments, and module plug-connector pin assignments.
10. The interlocking controller shall provide event recording. The event recording shall be designed so that the correct time is maintained when the vital logic and/or code system equipment is reset or powered down. The event recording equipment shall have sufficient storage capacity to store a minimum of seventy-two (72) hours of events, without overwrite, at

the interlocking, recording user selected status changes along with diagnostically important internal status changes.

11. The interlocking controller shall provide mitigation for "processor failure" via a fall back relay.
12. The interlocking controller shall interface with the solid-state track circuit detailed in Section 34 42 40, Solid -State Coded Track Circuits.
13. The failure of an output shall not cause loss of functions not associated with those of the failed module.
14. The interlocking controller shall operate from a standard 12 VDC signal battery supply. Any special power supply filtering devices required for reliable operation shall be provided as part of the system.
15. The interlocking controller shall, at a minimum, enable a user to generate the following reports:
  - a. Configuration report that, at a minimum, indicates controller location, revision history, controller/software identification (chassis identification), chassis slot assignments, application software identification (EPROM CRC/checksum), each vital and non-vital input/output assignment and nomenclature, each lamp driver vital output assignment and nomenclature, track code input/output assignment and nomenclature, serial and remote input/output assignment and nomenclature, vital timer configuration and time settings, and equation data recorder logging assignments.
  - b. Logic equation report that displays all application logic equations in a ladder-logic format.
  - c. Cross-reference report that displays all status names used in each logic equation.
  - d. Revision history report.
  - e. Real-time data logging that displays, on a user furnished computer display, changes in logic equation status.

B. Custom Local Control Panel (CLCP)

1. Local Control Panel (LCP) shall be a Custom Local Control Panel (CLCP). CLCP and shall be furnished as shown on the Contract Drawings.
2. The track display shall conform to the Contract Drawings.
3. The LCP shall be located on the equipment rack and shall permit convenient use. The faceplate track, switch, and signal layout shall conform to the Contract Drawings.

4. The LCP shall be mounted on a metallic enclosure. The faceplate shall be hinge mounted to provide front access to rear of faceplate and terminals mounted within metallic enclosure. The design and construction of the enclosure shall be dust-tight.
5. The LCP faceplate shall be constructed of anodized aluminum. The panel face shall be etched or silk-screened with a track diagram of the interlocking along with a symbol for each interlocking signal. Lettering shall be etched or silk-screened on the faceplate to identify switch and signal numbers as indicated on the Contract Drawings. The track plan shall be arranged to orient railroad east toward the right side of the panel.
6. Indication LED's and control push-buttons shall be as shown on the Contract Drawings.
7. A three-position, key-operated turn lever shall be provided on the face of the panel as shown on the Contract Drawings.
8. The LCP control board shall have the ability to communicate via RS-232, RS-485, 2000 Vrms isolated Current Loop and Ethernet, with support for Ansaldo PEER protocol and Alstom LCP protocol.
9. The LCP shall operate from a standard 12 VDC signal battery supply. Any special power supply filtering devices required for reliable operation shall be integrated as part of the system and be compliant with AREMA Wayside Class C requirements.
10. Contractor shall program and/or configure the LCP to provide manual control, allow CTC control, or function as indication only.
11. The local control panel board shall be capable of being configured via a USB port.
12. The local control panel board shall provide 128 physical inputs and 128 physical outputs, unless otherwise specified on the Contract Drawings.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Ensure that test and specialized installation equipment recommended by the manufacturer to make any readings or adjustments is in the Contractor's possession and within the project limits a minimum of 30 days prior to installation.

### **3.02 APPLICATION LOGIC**

- A. The Engineer shall furnish the application logic programs 90 days prior to performing in-service tests. The Contractor's Signal Engineer shall rack test the application logic at the SCRRA office in Pomona, CA. The Engineer shall observe the testing and shall make any modifications required to ensure the integrity and functionality desired.

- B. All time spent by the Contractor's Signal Engineer in rack testing or making modifications to the programs shall be at no additional cost to SCRRA. SCRRA shall not be responsible for any work delays that may result from software modifications made during final in-service testing and commissioning by the Contractor.

### **3.03 INSTALLATION**

- A. Wire and install the microprocessor-interlocking controller and the LCP in accordance with rack layout provided in the Contract Plans.
- B. Load all programmable and configurable modules with application software and perform any configuration necessary.
- C. Conduct a complete breakdown and operating test on the units prior to shipment.

### **3.04 FIELD QUALITY CONTROL**

- A. Conduct tests as specified in AREMA C&S Manual Parts 2.4.1 and 7.4.1 to ensure proper operation of the signal and grade crossing warning systems.
- B. Conduct tests to ensure that the signal system conforms to CFR 49, Part 236.
- C. Install and perform applicable tests in accordance with 34 42 58, Signal System Testing, to ensure that the interlocking controller software and LCP has been installed and made operational as part of the operating signal system. Verification of such tests shall be provided to the Resident Engineer.
- D. The Contractor shall conduct all tests as recommended by manufacturer.
- E. Testing, including pre-testing, shall include operating all switch machines and lighting all signals. The use of lamp simulators in lieu of, or in parallel with, signal lamps will not be allowed in pre-testing. An exception may be authorized by the Resident Engineer where a signal or switch machine is in service and will be reconfigured for final cutover or cannot be installed or wired until final cutover.

## **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 34 42 40**  
**SOLID-STATE CODED TRACK CIRCUITS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for furnishing, installing, testing, and documenting solid-state track circuit elements.
- B. Final application logic programs, including EPROMS, will be furnished by the Engineer.
- C. Related Specification Sections include but are not limited to:
  - 1. Section 34 42 38 – Interlocking Control
  - 2. Section 34 42 58 – Signal Systems Testing

**1.02 REFERENCES**

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
  - 1. Part 236 - Rules, Standards, and Instructions for Railroad Signal System
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communication and Signals Manual of Recommended Practices (C&S Manual).
- C. Southern California Regional Rail Authority (Metrolink) Engineering Standards

**1.03 SUBMITTALS**

- A. Submit a narrative explanation of the electrical and/or mechanical methods of configuration control used to ensure that the application logic software installed is the correct software for the specific location and that it is the latest version. It shall explain Contractor's procedures for handling components of the solid-state track circuit equipment.
- B. Submit certified acceptance reports.
- C. The Contractor shall submit to the Resident Engineer five (5) printed copies of all test reports and certify that all applicable tests have been made in accordance with Section 34 42 58, Signal Systems Testing.
- D. Submit a narrative explanation of Solid-State Coded Track Circuits changes sixty (60) in advance of any modifications, removals or additions. The narrative shall detail critical feature changes and provide checksum and CRCs of any

application program changes. These changes include both vital application and Positive Train Control (PTC) Map file changes.

- E. Rack test the application software. Rack testing shall mean that the software has been thoroughly tested and all possible conditions simulated using the same type of Solid-State Coded Track Circuits equipment and executive software being provided under this contract.

#### **1.04 QUALITY ASSURANCE**

- A. Install, configure, and test the solid-state track circuit equipment in accordance with all applicable requirements of CFR 49, Part 236, AREMA C&S Manual, Part 8.1.2 and the manufacturer's instructions.
- B. Perform operational testing of the equipment in accordance with the requirements specified in Section 34 42 58, Signal System Testing.
- C. All Solid-State Coded Track Circuits furnished under this Work shall be equipped with a PTC Wayside Interface Unit (WIU) and be compatible with the existing Metrolink PTC network. Solid-State Coded Track Circuits shall not require any additional interfacing equipment beyond what Metrolink currently uses.
- D. Contractor furnished software and components shall be new, manufacturer certified, and the latest SCRRRA approved version.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Package plug in modules for shipment separately from their card cage units using ESD safe packaging. Protect each item from damage or loss during handling and shipment.
- B. Clearly identify each controller unit and their associated components on the packing crate, referencing its intended location.

#### **1.06 WARRANTY**

- A. Provide warranty from defects for two (2) years from the first date of final acceptance.

### **PART 2 - PRODUCTS**

#### **2.01 MATERIALS**

- A. Electronic track circuits shall be compatible with highway grade crossing constant warning devices. Utilization of bi-directional, uni-directional, and auxiliary crossing control functions shall be provided per Contract Plans and manufacturer's specifications. Track filters shall be installed in track leads, as shown on the Contract Plans.



- B. Where new equipment is to be furnished and installed in existing locations, the equipment furnished shall be the same make as called for in the Contract Documents.
- C. Track circuit shall function to provide continuous train detection throughout the length of the circuit whenever a shunt of 0.06 ohms is applied to the rails, including applicable fouled turnouts.
- D. Furnish any specialized test or calibration instruments, equipment, or tools that may be needed to test and place in-service the equipment installed under this Section, as shown on the Contract Plans. Ensure all test and diagnostic equipment is in the Contractor's possession and within the project limits a minimum of 30 days prior to installation.
- E. Install Electro Code 5, with Alternating Code 5, manufactured by ALSTOM.
- F. Provide a solid-state electronic coded track signal system to determine block occupancy and to pass signal aspect information from one interlocking or signal location to the next. The system referenced herein is Electro Code 5 (EC-5).
- G. The electronic coded track circuit shall be user programmable to provide application logic changes as needed. The application program shall be specified on the release. The Contractor shall furnish executive programs specified with each electronic coded track circuit system.
- H. The electronic coded track circuit unit shall be configurable for transmission/reception of the track circuit and signal codes over the track.
- I. The coded track circuit unit shall have available a minimum of six (6) discrete code rates for vital signaling indication in addition to a code rate used for train detection. An additional code rate shall be available for reversal of the code transmission/reception signal orientation. Track circuit shall have two (2) codes used to convey non-vital block information. Electrocode IV code rates are presently used on Metrolink with Alternating Code 5. Coded Track Circuit must be able to communicate on the rails with existing Electrocode without requiring any interface equipment.
- J. Event recorder modules for electronic track circuits shall be provided as shown on the Contract Plans.
- K. Electronic coded track circuits shall conform to the requirements of the AREMA Signal Manual, Section 8.1.2, where these instructions and requisites are applicable and do not conflict with these Specifications.
- L. Conduct acceptance testing of components before transporting from the warehouse and installing. Provide certified acceptance reports at time of delivery.

**PART 3 - EXECUTION****3.01 PREPARATION**

- A. Ensure that test and specialized installation equipment recommended by the manufacturer to make any readings or adjustments is in the Contractor's possession and within the project limits a minimum of 30 days prior to installation.

**3.02 APPLICATION LOGIC**

- A. The Engineer shall furnish the application logic programs 90 days prior to performing in-service tests. The Contractor's Signal Engineer shall rack test the application logic at the SCRRA office in Pomona, CA. The Engineer shall observe the testing and shall make any modifications required to ensure the integrity and functionality desired.
- B. All time spent by the Contractor's Signal Engineer in rack testing or making modifications to the programs shall be at no additional cost to SCRRA. SCRRA shall not be responsible for any work delays that may result from software modifications made during final in-service testing and commissioning by the Contractor.

**3.03 INSTALLATION**

- A. Install solid-state coded track circuits at locations indicated on the Contract Plans.
- B. Install the solid-state track circuit equipment in signal instrument shelters or cases as shown on Contract Plans.
- C. The solid-state track circuit equipment layouts shall provide for easy access to test points, indicators, and adjustments.
- D. Install equipment in accordance with the manufacturer's installation and adjustment procedures.

**3.04 FIELD QUALITY CONTROL**

- A. Conduct tests as specified in AREMA C&S Manual Parts 2.4.1, 3.3.1, and 7.4.1 to ensure proper operation of the signal and grade crossing systems.
- B. Conduct tests to ensure that the signal system conforms to CFR 49, Part 236.
- C. Install and perform applicable tests in accordance with 34 42 58, Signal System Testing, to ensure that the Solid-State Coded Track Circuits software has been installed and made operational as part of the operating signal system. Verification of such tests shall be provided to the Resident Engineer.
- D. The Contractor shall conduct all tests as recommended by manufacturer.
- E. Testing, including pre-testing, shall include operating all switches and lighting all signals. The use of lamp simulators in lieu of, or in parallel with, signal lamps will

not be allowed in pre-testing. An exception may be authorized by the Resident Engineer where a signal or switch is in service and will be reconfigured for final cutover or cannot be installed or wired until final cutover.

#### **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 34 42 42

### SIGNAL LAYOUTS, STRUCTURES, AND FOUNDATIONS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. The work of this Section shall include disassembling, relocating and installing existing or new signals.
- B. Signal layouts, as specified herein, shall consist of foundations, signal heads and all structures including cantilevers, bridges, ground mounted masts, ladders, platforms, and all mounting hardware required to construct signals.
- C. Contractor shall furnish and install signals as shown on the Contract Plans at existing and new signal locations.
- D. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 03 31 00 – Structural Concrete
  - 2. Section 31 20 00 – Earthwork
  - 3. Section 34 42 58 – Signal System Testing
  - 4. Section 34 42 60 – Signal Systems Miscellaneous Products

##### 1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
  - 1. LTS-4 Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals
- B. American Railway Engineering and Maintenance-of-Way Association (AREMA)
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual)
- C. Southern California Regional Rail Authority (Metrolink) Engineering Standards
- D. Code of Federal Regulations, Title 29, Occupational Safety and Health Administration (OSHA)
  - 1. Part 1910 Subpart D “Walking-Working Surfaces”

### 1.03 DESIGN REQUIREMENTS

- A. Custom Signal Foundation Structures: Provide for the foundation structure type selection and its design. The design of the signal foundation's structure and stability shall be in accordance with the AASHTO LTS-4. Design calculations shall be prepared by a licensed California professional civil engineer with a minimum of 5 years experience in the design of similar foundation structures.
- B. Signal aspect shall be distinct and unmistakable when viewed from a height of 7 to 12 feet above top of rail at a distance of 1,000 feet. Nominal sighting distance shall be 2,000 feet. Where unobstructed sighting distance for a standard signal arrangement is less than 2,000 feet, supply and install color light LED signal and adjust the signal head for the maximum sighting range possible. Provide the Engineer written notification of any sighting problems or obstructions of signals..
- C. Signal foundations not requiring customization shall be in accordance with the applicable Metrolink Engineering Standards.

### 1.04 SUBMITTALS

- A. Submit Shop Drawings for each type of signal unit and each type of signal layout to the Engineer for approval. Show all ladders, masts, bases, arms, signal heads and required mounting hardware. Show location and method of mounting the signals to the structure.
  - 1. Provide necessary dimensions, hardware, method of mounting signal structures, and material specifications for all items to be furnished.
- B. Submit Shop Drawings for each type of structure foundation.
- C. Submit Installation Procedure for approval by the Engineer. The procedure shall include a detailed description of installation activity and sufficient detail to allow the Engineer to determine the validity of the installation procedure.
- D. Submit design calculations for signal cantilever or signal bridge foundations.

### 1.05 QUALITY ASSURANCE

- A. Signals, structures, and related hardware shall meet the requirements of AREMA C&S Manual, Section 7, and applicable portions of Manual Part 3.2.5 where they do not conflict with any requirements specified herein.
- B. Inspect each signal layout after it has been installed in the field. This inspection shall conform to the Contractor's Installation Procedure as accepted by the Engineer.
- C. L.E.D. signal lamp units shall meet the requirements of the AREMA C&S Manual Part 7.1.5.

- D. Foundations shall meet all requirements of AREMA C&S Manual Parts 14.1.1 through 14.4.41, where requirements of the AREMA Specifications do not conflict with any requirements specified herein.
- E. The Engineer reserves the right to make inspections and tests, as necessary, to determine if the equipment meets the requirements of this Specification.

### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Package LED's separately from the signal in which they will be used during shipment.
- B. Contractor shall ensure that all wayside signal assemblies and signal lamp units are safely stored and protected from damage during storage, handling and transporting.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

- A. Furnish LED color light signals, as indicated in the Contract Documents. Signals shall be in accordance with the Metrolink Engineering Standards.
- B. Color light signal units shall be capable of displaying three aspects: green, yellow and red as shown on SCRRA ES8525-01.
- C. Furnish signal masts, signal cantilevers and signal bridges, as applicable, in accordance with the Metrolink Engineering Standards.
- D. Furnish mounting brackets for marker light assemblies, ladders, junction boxes, housings, backgrounds, hoods and any other nuts, bolts, and associated hardware.
- E. Furnish foundations for signal masts, signal cantilevers and signal bridges, as applicable, in accordance with the Metrolink Engineering Standards.
- F. Install blank-out cover plates in all unused lamp units.

### **2.02 SIGNALS**

- A. Signal mounting shall conform to the Metrolink Engineering Standards.
- B. Signal LEDs shall be products specified in the Contract Documents or an approved equal.
- C. Signal LEDs shall be GE Lighting Solutions RM4 Series 96 LED Wayside Color Light units, or approved equal.
- D. Signal LEDs shall function with 12 VDC relay logic or directly from lamp driver modules within an ElectrologIXS, Vital Harmon Logic Controller, Electrocode 4, or Electrocode 5 controller. The LEDs shall be capable of light-out detection checks performed by solid state equipment.

**2.03 SIGNAL MASTS**

- A. Mast assemblies for ground mounting shall conform to the Contract Plans and the Metrolink Engineering Standards.

**2.04 SIGNAL BRIDGES AND CANTILEVERS**

- A. Refer to the Contract Drawings for signal bridge and signal cantilever requirements.
- B. The junction box shall have two terminals with insulated test links, as specified in Section 34 42 60, Signal Systems Miscellaneous Products, for each cable conductor. Provide ten (10) percent spare terminals.
- C. Cable entry to the junction box shall be direct from the signal structure. External conduit construction is not acceptable. Provide an opening approximately four by six inches near the base of the signal structure under each junction box location to allow access for cable sealing at the foundation. Provide bolt-on access plate which will cover the opening under normal conditions.
- D. Locate junction box either at the base of a main support mast or on a main support mast at a height of between 3 and 5 feet above the finished grade level at the base.
- E. The method of routing cables from the junction box to each signal mounted on the structure shall be to route the cables within the tubular members of the structure to the greatest extent possible. Pull cables entirely through the structure members, mast, and signal mounting brackets, unless otherwise approved by the Engineer. To facilitate this, provide appropriate pull box locations as needed, located a maximum of 5 feet from each signal. Edges shall be smooth and rounded to accommodate cable installation. Provide a means to prevent entry of rodents and insects at the bases of the vertical masts without cable entrances.
  - 1. Use galvanized rigid steel conduit where wire is to be run external to the structural members, except as noted.
  - 2. Use flexible armored conduit to make the connection from the pull box to the individual signal heads.
  - 3. Use 5C #10 signal color coded cable for mast and jct. box wiring, type TC Okonite 202-10-35-05 or an approved equal.

**2.05 SIGNAL FOUNDATIONS**

- A. Furnish galvanized steel foundations complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Specifications Section 34 42 60, Signal Systems Miscellaneous Products, and AREMA Signal Manual, Part 15.3.1.

- B. Construct galvanized steel foundations of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4 inch steel plate.
- C. Bolt spacing shall be to manufacturer's standards for the equipment to be supported by the foundation.
- D. Concrete Foundations: Cast-in-place in accordance with Section 03 31 00, Structural Concrete, or precast concrete as manufactured by Dixie Precast or an approved equal.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION - SIGNALS**

- A. Contractor shall install signal layouts in locations as indicated on the Contract Plans and as shown on the accepted Shop Drawings. No part of any signal layout shall conflict with Metrolink Engineering Standards, Code of Federal Regulations, Part 49, or CPUC rules and regulations.
- B. Locate signals centered between insulated joint, except where physically not possible. In such instances, submit a recommendation to the Engineer for approval.
- C. Center line of signal mast shall be 15 feet 0 inches from centerline of track unless a deviation from this is approved by the Engineer, as shown on the Contract Plans or required to meet CPUC clearance requirements.
- D. Install signal units level and plumb on their foundations. Leveling nuts shall be used as shown on the Metrolink Engineering Standards.
- E. Install signal layouts in accordance with the applicable requirements of AREMA Signal Manual, Part 7.4.1 and the Metrolink Engineering Standards.
- F. Install platforms for each signal unit level.
- G. Align signals for maximum viewing distance before placing in service.
- H. Refer to Design Requirements herein regarding signal aspect and sighting distances. Install signals and verify sighting distances. Provide the Engineer written notification of any sighting problems or obstructions of signals.
- I. Mount signal heads on an offset arm as shown in the Metrolink Engineering Standards. Signal heads shall also be able to swivel on the offset arm and be adjustable.
- J. Signal nomenclature shall be as shown on the Contract Plans and in accordance with Metrolink Engineering Standard 8130.



- K. The underground cable shall be dressed, pot headed, tagged, and terminated in the signal junction box in accordance with Metrolink Engineering Standard 8210. The conductor size of the underground cables shall be at least as large as that shown in the Contract Plans.
- L. Wiring from the junction box base to the signal heads shall be minimum No. 10 AWG copper stranded wire or larger as shown on the Contract Plans.
- M. Install identification tags on each wire. These tags shall bear the nomenclature shown on the accepted Shop Drawings.
- N. Set lamp voltage between 8.8 volts and 9.2 volts measured at the signal lamp.

### **3.02 INSTALLATION - SIGNAL BRIDGES AND CANTILEVERS**

- A. Signal bridges and cantilevers shall be installed as shown on Contract Plans.

### **3.03 INSTALLATION - FOUNDATIONS**

- A. Install each foundation in accordance with the approved Contractor's Installation Procedure for each type of foundation, as herein specified, and as shown on the Contract Plans. The absence of a specific task listing herein does not relieve the Contractor of the responsibility for providing a complete and functional installation.
- B. Refer to Section 31 20 00, Earthwork, for requirements for locating and protecting existing utilities. Advise the Engineer immediately if any utility or cable interferes with the foundation work. After locating an interference, allow 72 hours for the Engineer to relocate or mitigate the interference.
- C. Prior to placing steel foundations in the excavations, place and compact a crushed stone base in accordance with Section 31 20 00, Earthwork.
- D. When placing foundations, exercise care and ensure that anchor bolts are not bent or threads damaged. Protect anchor bolt threads, washers, and nuts by applying friction tape or other accepted method satisfactory to the Engineer, until the unit to be supported is installed.
- E. After backfilling foundations, ensure that the foundation is plumb and level. Where galvanized steel foundations are installed, top of final grade shall be no more than 24 inches below top of foundation.
- F. Install foundations to the lines, grades and dimensions required. Mounting bolts shall be of sufficient length to accommodate use of leveling nuts between the base of the equipment to be supported and the top of the foundation.

### **3.04 PAINTING**

- A. Touch up any damaged painted finish.

**3.05 FIELD TESTS**

- A. Make tests for proper operation and setting of lamp operating voltages in accordance with Section 34 42 58, Signal System Testing.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

- A. Signal Layout, Structures and Foundations 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. Signal Layout, Structures and Foundations 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 34 42 42**

**SECTION 34 42 43**  
**ELECTRIC SWITCH LOCK LAYOUTS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This section includes requirements for Electric Switch Lock Layouts.
- B. Refer to Division 34, Transportation, for track construction requirements.

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA)
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual)
- B. Southern California Regional Rail Authority (Metrolink) Engineering Standards

**1.03 SUBMITTALS**

- A. Submit installation drawings showing the tie straps and the mounting details of the switch circuit controller, including the connections to the track switch points and switch stand being used for the Work.
- B. Submit copies of all field-test reports.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Prior to installation, coat all parts of the Electric Switch Lock Layout that are not painted or made of non-corroding material with approved grease to prevent corrosion. Appropriately plug or cap unused threaded outlets.
- B. During storage, lubricate and maintain Electric Switch Lock and switch circuit controller layouts on a regular time program until installation. The Resident Engineer shall have the right to monitor the Contractor's compliance with this maintenance required from time to time.

**PART 2 – PRODUCTS**

**2.01 MATERIALS**

- A. Furnish new Low Style Electric Lock Operating Mechanisms and layouts, such as G & B Specialties Model 854 or Alstom Model 9B.
- B. Furnish new High Style Electric Lock Mechanisms and layouts, such as Alstom Model 9B or US&S Model SL6A.

- C. Rods and Hardware. Each Low Style Electric Switch Lock shall securely lock the switch hand throw lever in the normal position only. Provide a single color LED with the assembly to indicate switch lock release. Each High Style Electric Lock shall have a separate lock rod attached to the vertical front rod.
- D. Junction Boxes. Each Electric Switch Lock layout shall be installed with an individual pedestal mounted junction box. These junction boxes shall be as specified in Section 34 42 60, Signal Systems Miscellaneous Products.
- E. Electrical Fittings. All conduit, connectors, and electrical fittings, as required for each electrical lock layout.
- F. Switch Circuit Controller and Rod. Switch circuit controller layouts shall be installed as specified in Section 34 42 50, Switch Circuit Controller
- G. Stranded Wire. Furnish insulated No. 10 AWG stranded wire between the pedestal-mounted junction box and the switch circuit controller. Insulated wire shall be in accordance with Section 34 42 16, Signal Wires and Cables.

## **2.02 SECURITY**

- A. Provisions shall be made for the use of standard padlocks:
  - 1. A switch padlock to restrict entry into the operating handle location of the Electric Switch Lock.
  - 2. Signal padlocks to restrict entry into the Electric Switch Lock operating mechanism, the circuit controller, and the junction box.
- B. Padlocks will be furnished by SCRRA.

## **2.03 SOURCE QUALITY CONTROL**

- A. Perform Contractor's acceptance test of each Electric Switch Lock layout prior to transporting the Electric Switch Lock layout.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. The circuits for Electric Switch Lock layouts shall be shown on the Contract Drawings.
- B. Mount and adjust the complete switch circuit controller layout as specified herein and as indicated on the Contract Drawings.

### **3.02 INSTALLATION**

- A. Install two 16-foot long timber ties or concrete ties for mounting the Electric Switch Lock where Alstom Model 9B or US&S Style SL-6A Electric Locks are used and furnished by the Contractor, as shown on the Contract Drawings.

- B. Mount Electric Switch Lock and switch circuit controller on new and existing timber or concrete ties in conformance to Metrolink Engineering Standards.
- C. Dap and drill timber ties to meet requirements of these Specifications. Limit of cutting or dapping shall not exceed 2 inches.
- D. Secure the Electric Switch Lock and switch circuit controller to the switch ties, by 3/4 inch by 10 1/2 inch bolts.
- E. Remove any ballast necessary for the installation of the Electric Switch Lock layout and replace and tamp the ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the switch and lock movement layout.
- F. Make a preliminary adjustment of the Electric Switch Lock and switch circuit controller layout at the time of installation, and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of functional test. Make final adjustments in conformance with the requirements of AREMA C&S Manual, Parts 12.5.5 and 2.4.1.
- G. Underground cable terminating in the Electric Switch Lock and switch circuit controller junction boxes shall be dressed and pot headed as specified in Section 34 42 16, Signal Wires and Cables. Fan the individual conductors in a neat workmanlike manner, properly tagged and terminated. Wiring between switch junction box and Electric Switch Lock and switch circuit controller shall be No. 10 AWG insulated stranded flex wire. These wires shall also be tagged and terminated. Install the wires between the Electric Switch Lock and switch circuit controller mechanisms in an approved flexible conduit with a minimum length of 10 inches and a maximum length of 21 inches. Fasten this flexible conduit to the switch junction box and switch mechanism with appropriate connectors.
- H. After installation, properly lubricate and maintain Electric Switch Lock and switch circuit controller layouts on a regular timed program until accepted by the Resident Engineer.
- I. Exercise care and ensure that the Electric Switch Lock and switch circuit controllers, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease as acceptable to the Resident Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.
- J. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Resident Engineer. Thoroughly steam clean the plates to remove all oil or grease prior to application of the graphite. Periodically renew the protective coating until such time as Metrolink assumes responsibility for maintenance of the equipment.
- K. Connect electric switch lock rod and switch circuit controller rods to the normally closed switch point.

- L. Any switch assembly which is connected to the open point side, or which has a reverse switch indication shall be equipped with an insulated front rod in accordance with Metrolink Engineering Standard 8650.

### **3.03 SECURITY**

- A. Install SCRRA furnished padlocks.

### **3.04 TOUCH-UP**

- A. Touch-up finish of all equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Touch up shall match factory finish.

### **3.05 FIELD QUALITY CONTROL**

- A. Inspect each Electric Switch Lock after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Procedure as accepted by the Resident Engineer.
- B. Conduct the final operational tests of Electric Switch Lock Layouts and switch circuit controllers as described in Section 34 42 58, Signal System Testing.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Electric Switch Lock Layout 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. Electric Switch Lock Layout 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 34 42 44**

### **RELAYS**

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

##### **1.01 SUMMARY**

- A. This Section includes requirements for relays. Unless indicated as relocated on the Contract Plans, relays shall be Contractor furnished and relays of each type shall be uniform in design and contact assembly.
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 01 40 00 – Quality Requirements
  - 2. Section 34 42 58 – Signal System Testing
  - 3. Section 34 42 60 – Signal Systems Miscellaneous Products

##### **1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- B. Southern California Regional Rail Authority (Metrolink) Engineering Standards

##### **1.03 SUBMITTALS**

- A. Contractor shall provide acceptance testing and documentation for each relay when it is transported from the warehouse to the job site.
- B. Submit sample relay identification tag, including method of mounting proposed.
- C. Complete Test Report Form provided by the Engineer for each vital relay installed under this Contract. Use typewritten characters to fill in all information requested on the form.

##### **1.04 QUALITY ASSURANCE**

- A. Vital relays shall meet the requirements of AREMA C&S Manual Part 6.2.1, where they do not conflict with any requirements specified herein. Vital Relays shall be of the type and quality as designated in the Metrolink Engineering Standards 8110 and 8120.
- B. Factory testing of each relay shall be the manufacturer's standard.
- C. Provide relay specifications including drop away, pick up and working values, any

special mounting or supporting arrangements, and contact stacking arrangements, for all relay types to be furnished under this Contract. Include any arc suppression where arc suppression is required.

- D. Before any relay is used, obtain the Engineer's written acceptance. Acceptance will be based on the test results and the proper completion of the Test Report Form.
- E. The Metrolink Engineering Standards depict acceptable relays in use. If the Contractor proposes use of alternate relays not listed, and those alternate relays have been approved by the Resident Engineer, the Contractor shall submit manuals with comprehensive descriptions and illustrations of each type of alternate relay provided. The Contractor shall provide four relay manuals, four copies of relay specifications, and calibration sheets for each type of alternate relay furnished.
- F. The Contractor shall provide field test reports indicating each relay furnished has conformed to the manufacturer's specifications and the relay conforms to CFR 49 Part 234 and Part 236 requirements. The use of type written characters shall be used to fill in all information requested on the form.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Ship vital relays separately from the wired racks in which they are to be used. Package relays individually; each in a sturdy corrugated cardboard carton with the part number of the relay printed on the outside of the carton. Store relays in a protected area until tested and installed.
- B. Ensure that all vital relays are safely stored and protected from damage during storage, handling and transporting.

### **1.06 SPARE PARTS AND SPECIAL TOOLS**

- A. The Contractor shall furnish one (1) e-post wrench for opening and closing the relay test terminals with each shelter where relays are installed. E-post wrench must be in each shelter for final acceptance.
- B. The Contractor shall furnish two (2) insertion/extraction tools for each type of contact at each shelter where relays are installed. Insertion/extraction tools must be in each shelter for final acceptance.

### **1.07 WARRANTY**

- A. The Contractor shall provide warranty from defects arising from defective parts and workmanship for 2 years from the first date of final acceptance.

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. Relays shall be in dustproof enclosures; however, a provision shall be made for ventilation where required for heat dissipation.



## 2.02 VITAL DC RELAYS

### A. General:

1. Vital Relays shall be Alstom Type B, Siemens Type "ST", or an approved equal. Contractor shall use the specific relays shown on the Contract Plans.
2. Vital DC relays, unless otherwise indicated on the Contract Plans, shall be of the plug-in type and rack-mounted. Relays shall have a transparent dust cover made of a nonflammable composition that will not support combustion.
3. Vital Relays, with a nominal operating voltage of 10 to 16 volts, shall be capable of operating continuously without resultant damage, with a minimum voltage range of 7 to 21 volts inclusive, applied to their operating circuits.
4. Vital relays shall have a test terminal to allow convenient measurement of the coil voltage.
5. Design biased neutral vital relays so that gravity alone will prevent the armature from picking up if the permanent magnet is de-energized or if no current is applied to the coil, due to interruption of the normal magnetic circuit.
6. All front contacts shall be silver-to-metal carbon, meeting the requirements of the AREMA C&S Manual Part 6.2.1.
7. When three DC vital relays, suppressed as specified herein, are connected in parallel and operated as a test load from normal working voltage, a vital relay front or back contact that breaks this load shall be capable of at least five million operations at this load without the contact resistance, measured with ten milliamp currents, exceeding five ohms.
8. Arc suppression for vital relays shall be built into the relay or into its plugboard.
9. Equip vital plug-in relays, except for vital time-element relays and special application relays, with front current testing facilities. Where shown on the Contract Plans, provide facilities to enable the testing of voltage from the front of the relay, without having to remove the relay or remove adjacent relays.
10. Equip vital relays with a registration plate to prevent relays of the wrong style, contact arrangement, or operating characteristics, from being inserted into the plug board.

## 2.03 SWITCH OPERATING RELAYS

- ### A.
- Vital switch operating relays used for control of switch-and-lock movement shall meet the same requirements as specified for vital biased neutral relays except that

a minimum of two front-back dependent contacts or two independent front contacts and two independent back contacts shall be required.

- B. Each contact shall be equipped with a magnetic blow-out feature to effectively interrupt high currents and minimize contact wear. Switch operating relays to be furnished under this Contract shall be identical: one normal and one reverse switch-operating relay shall be provided for each switch-and-lock movement.

## **2.04 IDENTIFICATION**

- A. Facilities shall be included for mounting an approved typed or printed relay nametag for each relay, either on the relay cover or on the relay cabinet front plate, as applicable. The nametag shall be easily replaceable but shall not come off during normal service.
- B. Identification shall be in accordance with Section 34 42 60, Signal Systems Miscellaneous Products.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Ensure that the relay operating characteristics have not been altered during shipping.
- B. Ensure that all AC and DC power buses are open while installing relays. Do not reconnect buses until all relays have been installed.
- C. Install and wire the relays as shown on the Contract Plans. Contractor shall refer to Metrolink Engineering Standards 8110 and 8120 for relay tab and coil wiring information.
- D. Identify each relay with nametag(s) as approved by the Resident Engineer.

### **3.02 FIELD QUALITY CONTROL**

- A. All DC vital relays shall be tested and inspected in accordance with AREMA C&S Manual Part 6.4.1.
- B. Perform tests in accordance with Section 34 42 58, Signal System Testing.
- C. Record test measurements on Test Report Form provided by the Engineer.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Relays 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. Relays 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 34 42 46**  
**SIGNAL EQUIPMENT HOUSES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for new factory-wired signal equipment houses and relocating existing signal equipment houses. The Contractor shall be responsible for supplying new house(s).
- B. Installation and field modification of the new factory-wired signal equipment houses by the Contractor to meet the requirements of the Contract Plans shall meet or exceed the requirements of this Section.
- C. Signal Equipment Houses may be referred to as instrument enclosures, instrument houses, crossing houses, signal shelters in these Specifications.
- D. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 34 42 00 – General Signal Requirements
  - 2. Section 34 42 16 – Signal Wires and Cables
  - 3. Section 34 42 56 – Signal Grounding
  - 4. Section 34 42 58 – Signal System Testing
  - 5. Section 34 42 60 – Signal Systems Miscellaneous Products
  - 6. Section 34 42 62 – Service Meters

**1.02 REFERENCES**

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
  - 1. Part 234 Grade Crossing Signal System Safety
  - 2. Part 236 Rules, Standards, and Instructions for Railroad Signal System
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- C. Southern California Regional Rail Authority (Metrolink) Engineering Standards

**1.03 SUBMITTALS**

- A. Submit proposed Installation Test Procedures.
- B. Submit load calculations, indicating sizes of load center panel, voltage drops, and all other 240/120 Vac equipment.
- C. Submit Contractor's Inspection and Acceptance Procedure prior to transporting new signal equipment houses to the job site.
- D. Submit four (4) copies of Shop Drawings showing the proposed size and equipment layout including rack, air conditioner, lighting, convenience outlet arrangement, and exhaust fan mounting and location.
- E. Submit four (4) copies of Shop Plans of each instrument and entrance rack, showing the arrangement and description of the mounted equipment and wiring, if different from those shown on Contract Plans.
- F. Submit four (4) copies of Shop Drawings of the complete grounding arrangement.
- G. Submit proposed Factory Acceptance Test Procedures.
- H. Shop Drawings shall be submitted within thirty (30) days of NTP.

#### **1.04 QUALITY ASSURANCE**

- A. The instrument enclosures shall be assembled and wired to conform to the Contract Plans. Contractor shall ensure the enclosures are free from defects and that workmanship is of the highest quality.
- B. Each house will be inspected after it has been installed and the Contractor shall correct any deficiencies. This inspection will be conducted in conformance with the requirements of the Contractor's accepted Installation Inspection Procedure.
- C. The Contractor shall provide documentation of acceptance "in good condition" before removing and transporting existing houses to the job site.
- D. The Contractor shall provide documentation of Factory Acceptance Testing before transporting new houses to the job site.
- E. Each house and case will be inspected after they have been installed and the Contractor shall correct any deficiencies. This inspection will be conducted in conformance with the requirements of the Contractor's accepted Inspection and Acceptance Procedure.
- F. Resident Engineer reserves the right to make inspections and tests at the facility where the wiring services are to be performed to determine if the equipment and workmanship meets the requirements of this Specification.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Properly fasten and brace equipment shipped within houses and cases to prevent damage during transit. Replace any equipment damaged during transit or prior to in-service operation at no cost to the Owner.
- B. Package all vital relays, batteries, and electronic plug-in modules in separate containers for shipment and do not install until the house is set at its final location.

## **PART 2 – PRODUCTS**

### **2.01 HOUSE GENERAL**

- A. Furnish and install factory-wired signal equipment houses, as described herein and as shown on the Contract Plans. These houses shall be complete with all the equipment shown on the Contract Plans. Wiring shall conform to the requirements of the AREMA C&S Manual, NEMA Standard ICS-70, or National Electrical Code (NEC), as applicable.
- B. Signal equipment houses shall be products manufactured by PTMW, Inc., Siemens Mobility Solutions, TCR Rail Systems or an approved equal.
- C. Signal equipment houses shall be the size and layout shown on the Contract Plans.
- D. Signal equipment houses shall be rain-tight and dust-tight, National Electrical Manufacturers Association (NEMA) 3R, ventilated, and have hinged doors with three point catch and handle and have welded construction throughout. Welds shall be 1-1/2 inch minimum in length with spacing not to exceed 6-inches where panels meet floor and roof. Spacing on panel welds shall not exceed 18-inches.
- E. Signal equipment houses shall be constructed of 12-gauge galvanized steel for floors, walls, and doors. Roofs shall be no less than 14-gauge galvanized steel with a minimum of 50 lb/ft<sup>2</sup> loading or as shown on the Contract Plans.
- F. The entire structure shall be powder coated on the outside with TGIC Polyester Powder (or equal polyester powder) with a nominal thickness of four mils, but no less than three mils at any point on the surface of the enclosure in accordance with AREMA C&S Manual Part 1.5.10. The exterior color shall be light gray.
- G. The instrument enclosures shall be complete with moveable shelves, wire chase, and backboard.
- H. The signal equipment houses shall provide access to underground and aerial cable entrance behind the main terminal rack. The top and sides shall be lined with temperature insulating material and constructed to prevent sweating. Provide ventilation openings as required for the size of the house proposed. No ventilation opening shall be made in the roof of the house. Provide lift rings to facilitate the movement of the house.
- I. Provide ventilation openings in each door. The exterior of the ventilation openings shall be hooded to minimize the entrance of precipitation. Equip the interior of ventilation opening with sliding plate to allow the adjustment of airflow and with a replaceable dust filter. The doors shall be hinged and gasketed so that they will

- provide a dustproof and weatherproof seal. Provide doors with exterior and interior handles, (interior handles not required on cases) welded to a three-point locking device to ensure that the door cannot be locked until it is in the fully closed position. Provide doors with a two-position retaining device to secure the door when open.
- J. House access doors shall be equipped with an additional locking mechanism such as the Master Lock 770 Hidden Shackle Padlock Hasp, or approved equal.
  - K. Door openings shall be 32 inches wide by 86 inches tall unless otherwise specified on the Contract Plans.
  - L. Provide thermostatically controlled exhaust fans, operated from 120 Vac and fused separately, in each house, as shown on the Contract Plans. The thermostat that activates the fan control shall be adjustable and operate in the range of 70 degrees to 130 degrees Fahrenheit. Locate fans relative to the fresh air inlets to draw air over the equipment and size to renew the air within the house every 3 minutes. Exhaust fans shall have removable dust filters. Dust filters shall be either replaceable or cleanable.
  - M. Hinges shall be separate castings, securely fastened to the house and door. The hinges shall be equipped with bronze hinge pins, shall be lubricated by the manufacturer before the case is shipped, and shall have grease fittings for future lubrication.
  - N. Furnish signal equipment houses with interior lighting and duplex 120 VAC power receptacles. Signal equipment houses and cases with double tube LED fluorescent lights, energy efficient, as required to provide complete illumination for all passages and sides, and operated from a switch conveniently placed near each entrance door. Furnish convenience outlets as part of each switch.
  - O. House lighting and receptacle loads shall be fed from a ground fault interrupt circuit breaker used exclusively for these loads. Signaling logic and signal appliance power loads shall be fed from separate circuit breakers. The signal logic power and signal appliance power shall be ungrounded. The Contractor shall size circuit breakers and wiring.
  - P. Furnish Signal Equipment Houses complete with a 120/240 Vac power distribution panel, circuit protective devices, and all appurtenances necessary to supply the AC power required at each site.
  - Q. All access points in the enclosure shall be sealed for weather protection and against entry of rodents and insects. All interior and exterior seams shall be caulked with RTV silicone.
  - R. Enclosure foundations shall be the inner wall type and adjustable from the outside of the enclosure. The range of adjustment shall be from 36-inches to 52-inches in 1/2-inch increments. Foundations shall be galvanized steel, a minimum of 60-inches long, include all hardware, and a 12-inch x 12-inch x 1/4-inch footing pad. All galvanizing shall conform to the AREMA Signal Manual, Part 15.3.1

- S. Permanent vendor name plate, or equivalent, complete with vendor name, address, model number, serial number, and date of manufacture or equivalent shall be located on front the of house above the main entrance door.

## 2.02 CASE GENERAL

- A. Case shall have welded construction throughout. Welds shall be 1-1/2 inch minimum in length with spacing not to exceed 6-inches where panels meet floor and roof. Spacing on panel welds shall not exceed 18-inches.
- B. Interior surfaces including top, sides, and shelves shall be finished with primer coat and two (2) coats of white latex enamel paint.
- C. All paint shall be fire retardant.
- D. Key slot channels shall be provided on each side and extend to the full inside heights of the case. Keyhole spacing shall be 2-1/2 inch centers. Key slot channels shall be flush with insulation.
- E. Sides, top, and doors shall include 1-inch of fiberglass faced polyisocyanurate insulation. Floor shall include 1/8-inch bi-directional pyramat rubber matting.
- F. Permanent vendor name plate, or equivalent, complete with vendor name, address, model number, serial number, and date of manufacture or equivalent shall be located on front of the case.
- G. Cases shall be equipped with a minimum of two (2) lifting/tie down lugs located at roofline on each side.
- H. Cases shall include four- (4) knockouts with cover plates and gaskets on sides 'A' and 'C' in the upper corners. Internal insulation at entry locations shall be precut for ease of removal and equipment installation.
- I. All access points in the case shall be sealed for weather protection and against entry of rodents and insects. All interior and exterior seams shall be caulked with RTV silicone.
- J. Exterior shell shall be constructed of 12-gauge galvanized steel.
- K. Exterior surfaces, including bottom of floor, shall be powder coated with TGIC polyester, color light gray, nominal thickness of 4 mils but not less than 3 mils thick.
- L. Shelving and backboard shall be constructed of 3/4-inch MDO two-sided plywood and finished on all sides, with primer coat and two - (2) coats of fire retardant white latex enamel paint, before mounting.
- M. Shelving shall be adjustable vertically in 2-1/2 inch increments and conform to the Contract Plans.



- N. Shelves shall be 12-inches wide and covered with 1/8-inch bi-directional pyramat rubber matting. The shelf length will be determined by case size or as shown on the Contract Plans.
- O. All exposed edges on shelving, including rear edge, shall have a 1-inch facing constructed of 14-gauge sheet metal, designed for this purpose. Facing shall be aluminum or steel with rust preventive paint or plating. Facing shall be attached with screws and be free of burrs or sharp edges.
- P. Surface area of backboards and shelves shall be free of protrusions such as bolt heads. The bottom of the backboards shall be cut level as shown on the Contract Plans.
- Q. The width of the backboard shall be determined by the size of the case or as shown on the Contract Plans.
- R. Door gasket shall be compressed 1/2-inch free height when door is closed and locked. The gasket shall be coated with an approved lubricant to prevent sticking.
- S. Three bolt on hinges, separate castings, with bronze hinge pins and lubrication (3/16-inch zerk), fittings shall be installed with an anti-theft arrangement.
- T. All doors shall be lubricated before shipment from the factory.
- U. Heavy-duty three point locking system shall be furnished with each door. Latch and locking system shall operate smoothly through complete opening and closing cycle. The door handle must accept a large bail padlock. (Polar Hardware brand #7011) or approved equivalent.
- V. Case access doors shall be equipped with an additional locking mechanism such as the Master Lock 770 Hidden Shackle Padlock Hasp, or approved equal.
- W. Doors shall be provided with rods to hold door open at 90 degrees and near 180 degrees. Door insulation shall be covered by an interior sheeting to protect the insulation and to add rigidity to door.
- X. Louvers shall be provided in doors with adjustable cover plates for winter and summer usage. The door shall accommodate an adjustable air intake sized to accept a 1-inch x 10-inch x 20-inch replaceable filter.
- Y. A drip channel (or roof design) shall be incorporated into the design to direct water away from opening. Y.
- Z. Case shall include six (6), 4-5/8" knockouts in the floor behind the backboard with cover plates. Four (4) cable risers 36 inches long, complete with male adapters, lock nuts, and bushings shall be included. The knockouts shall be equally spaced behind the backboard.

### **2.03 HOUSE GENERAL ELECTRICAL SPECIFICATIONS**

- A. All vendor installed electrical products shall be UL listed. All electrical work shall conform to the National Electrical Code (NEC) standards and accepted practices.
- B. Conduit and device box sizes shall conform to NEC Article 370.
- C. The typical Breaker box shall be Square 'D' 100 AMP; Model QO12M100. The breaker box shall be furnished with the following breakers, one- (1) QO120 GFI, one- (1) QO230, one- (1) QO130, and seven- (7) QO120.
- D. Bushings shall be installed on all conduits entering or leaving the breaker or device boxes. An SDSA-1175 surge arrestor shall be mounted on the top of the breaker box.
- E. The breaker box ground buss shall be bonded to the breaker box and the nearest keyway using an ERICO 'VS' welded connection designed for this purpose. The neutral buss shall not be bonded during manufacture. The field shall bond the neutral at the remote (main) disconnect when used.
- F. The neutral bonding screw shall be packaged and shipped in the breaker box for installation in the field if necessary.
- G. All conduits shall be installed above the wire chase and secured to enclosure structure. Flex conduit shall not be used except when used as a drop or attached to equipment that maybe removed. All circuits must be routed in separate conduits. The fluorescent lamp fixtures shall not be used for a junction box, raceway or conduit for any circuit other than the one intended for lamp operation.
- H. One (1) separate 20 AMP plug circuit shall be provided on the 'A' and 'C' walls as shown on the Contract Plans. The end plugs shall be 8-inches from the 'D' wall and 18-inches from the 'B' wall the remaining plug(s) shall be centered between them.
- I. Separate 20 AMP circuits (equipment power drops) shall be provided on the 'A' and 'C' walls. The junction boxes shall be located, above the wire chase, as shown on the Contract Plans. The wires from the panel shall be terminated (wire nut and taped) in the junction box. One-(1) piece of aluminum flexible conduit, 48-inches long shall be supplied for each junction box and installed by the wiring shop. The conduit shall be coiled up and shipped along with other house material.
- J. Bungalows to have provisions for connection of an auxiliary generator as shown on the Contract Plans. Provisions for this arrangement to include the following: 1ea. 125/250V 3-pole 4 wire flange male inlet plug NEMA Type L14-30P with exterior spring loaded weather proof outlet cover (Bryant #71430-MBWP). Main breakers to be 100 AMP (Square 'D' #QO2100) for bungalows with 2-pole 30 AMP breaker (Square 'D' #QO230) positioned adjacent to main breaker with mechanical interlock (Square 'D' # QO2DTI). DO NOT SUBSTITUTE.
- K. General color code and wire specifications for all AC wiring are as follows. All wiring shall be THHN or THWN solid copper or as required by the NEC.

GFI Breaker to Receptacle/Thermostat	#10 Black
GFI Breaker to Receptacle	#10 White
GFI Receptacle Ground	#10 Green
Thermostat to Vent Fan	#10 Red
Fan Neutral	#14 White
Breaker to Light Switch	#10 Black
Light Switch to Light	#10 Red
Light Neutral	#10 White
Breaker to Receptacle A & C walls	#10 Black
Receptacle Neutral	#10 White
Receptacle Ground	#10 Green

- L. The service entrance shall be a 2-inch EMT conduit, entering the bottom of the breaker box. The conduit shall extend through the floor. Sufficient length shall be left to allow easy coupling. The open end shall be capped and protected while in transit.
- M. One (1) 36-inch piece of 2-inch EMT conduit shall be included along with a compression coupling. The conduit and coupling shall be secured and shipped inside the enclosure.
- N. A single or 3-way light circuit shall be provided based on house size and door arrangement. One (1) 115/120V-20 AMP duplex receptacle shall be mounted with each light switch, near the main enclosure entrance (D and/or B-wall). The fan thermostat control unit shall be mounted to the light switch/duplex receptacle handy box on 'D' wall.
- O. A minimum of two (2) double tube, 4-foot LED energy efficient fluorescent fixtures, and tube guards shall be installed in each enclosure. The actual quantity and location of lights shall be based on the enclosure size or as shown on the Contract Plans.
- P. An air conditioner, sized for the structure, shall be supplied and located as shown on the Contract Drawings. A 20 AMP circuit, with a single 20-amp receptacle, configured for air conditioner unit provided shall be provided. All air conditioners shall be commercial grade, 220/240Vac rated units with a minimum BTUh rating of 12,000. Air conditioners shall be provided with a minimum warranty period of five (5) years. Contractor shall furnish Kenmore Elite Model #76125, or approved equal.
- Q. Bushings shall be installed on all conduits entering or leaving the breaker or device boxes. An SDSA-1175 surge arrestor shall be mounted on the top of the breaker box.

## 2.04 CASE GENERAL ELECTRICAL SPECIFICATIONS

- A. All vendor installed electrical products shall be UL listed. All electrical work shall conform to the National Electrical Code (NEC) standards and accepted practices.

- B. The breaker box for cases shall typically be a Square 'D' 100 AMP; Model QO6-12L100S mounted as shown on the Contract Drawings. Circuit breakers supplied with the case shall be Square 'D' QO series as follows, one- (1) QO120 GFI, two- (2) QO120.
- C. Conduit and device box sizes shall conform to NEC Article 370.
- D. Bushings shall be installed on all conduits entering or leaving the breaker or device boxes. An SDSA-1175 surge arrestor shall be mounted on the top of the breaker box.
- E. The breaker box ground buss shall be bonded to the breaker box and the enclosure frame using an ERICO 'VS' welded connection designed for this purpose. The neutral buss shall not be bonded during manufacture. The field shall bond the neutral at the remote (main) disconnect when used.
- F. The neutral bonding screw shall be packaged and shipped in the breaker box for installation in the field if necessary.
- G. General color code and wire specifications for all AC wiring are as follows. All wiring shall be THHN or THWN solid copper or as required by the NEC.

GFI Breaker to Receptacle	#10 Black
GFI Breaker to Receptacle	#10 White
GFI Receptacle Ground	#10 Green
Breaker to Light Switch	#10 Black
Light Switch to Light	#10 Red
Light neutral	#10 White

- H. The service entrance shall be a 2-inch EMT conduit, entering the bottom of the breaker box. The conduit shall extend through the floor. Sufficient length shall be left to allow easy coupling. The open end shall be capped and protected while in transit.
- I. One (1) 36-inch piece of 2-inch EMT conduit shall be included along with a compression coupling. The conduit and coupling shall be secured and shipped inside the case.
- J. Cases to have provisions for connection of an auxiliary generator as shown on the Contract Plans. Provisions for this arrangement to include the following: 1ea. 125/250V 3-pole 4 wire flange male inlet plug NEMA Type L14-30P with exterior spring loaded weather proof outlet cover (Bryant #71430-MBWP). Main breakers to be 60 AMP (Square 'D' #QO260) for signal cases with 2-pole 30 AMP breaker (Square 'D' #QO230) positioned adjacent to main breaker with mechanical interlock (Square 'D' # QO2DTI). DO NOT SUBSTITUTE.
- K. 6-9 cases shall include one (1) switched incandescent light circuit. The fixture shall be complete with 100 watt equivalent lamp and metal lamp guard.

- L. A GFI protected duplex plug and light switch shall be mounted inside on the end (C) wall as shown on the Contract Plans. The light with metal guard shall be mounted in the front at the top-center of the case.
- M. 6-9 case shall be equipped with an exhaust fan to afford proper air circulation throughout the interior of the case.

## **2.05 SIGNAL EQUIPMENT MOUNTING**

- A. General:
  - 1. Mount equipment as shown in the Contract Plans.
  - 2. Mount all equipment in such a manner that a seismic event within the parameters of Section 34 42 00, General Signal Requirements, will not cause damage or excessive motion.
- B. Relay Plugboards:
  - 1. Design plugboards for insertion of removable type contacts. The method of attaching the wires to the removable contacts shall be solderless connections. Design plugboard so that the removable contact will have a direct connection with the contact and coil prongs. The plugboards shall be in accordance with the applicable sections of AREMA C&S Manual, Part 6.2.2.
  - 2. All wires shall be of sufficient length to permit them to be moved to any contact on the same relay.
  - 3. Equip the plugboards for vital relays with a registration plate to prevent relays of the wrong type, contact arrangement, or operating characteristics from being inserted.

## **2.06 IDENTIFICATION**

- A. Stencil a white identification number at the top of the front and rear frames of each rack or panel.
- B. There shall be an identifying nameplate for each relay, or other instrument mounted on the rack or panel.
- C. Equip the back and front of the relay plugboards with a tag, as specified in Section 34 42 60, Signal Systems Miscellaneous Products. This tag shall indicate the nomenclature of the relay.
- D. Identify terminals and both ends of all wires with a wraparound tag printed with the circuit nomenclatures and terminal designations as shown on the Contract Plans and as specified in Section 34 42 60, Signal Systems Miscellaneous Products.

- E. Wire and cable conductor identification tags for terminal board mounting shall be as specified in Section 34 42 60, Signal Systems Miscellaneous Products.

## **2.07 CABLE ENTRANCE TERMINAL BOARDS**

- A. Cable entrance terminal boards shall be 3/4-inch Type AB exterior (five ply) plywood, mounted on a rack and painted white with a fire retarding paint.
- B. Cable entrance terminal boards shall be located as shown on the Contract Plans.
- C. Multiple-unit terminal blocks for wire and cable conductors shall be in accordance with AREMA C&S Drawing 14.1.6. Furnish each binding post with two binding nuts, one clamp nut, and three washers.
- D. Provide Siemens or equal test links on all terminal pairs where conductors enter houses.
- E. Equip binding posts and exposed terminals of other apparatus for circuits exceeding 50 volts or greater (ac or dc) with insulating nuts and sleeves.
- F. Cable entrance facilities shall be located as shown on the Contract Plans.
- G. Lightning arresters shall be as specified in Section 34 42 60, Signal Systems Miscellaneous Products.

## **2.08 CABLE ENTRANCE PIPES**

- A. Supply cable entrance pipes as specified in Section 34 42 60, Signal Systems Miscellaneous Products.

## **2.09 GROUNDING**

- A. House shall be fitted with four 48-inch long No. 2 ground wires cadwelded to floor frame of the house at each corner. Cadwelding shall take place prior to powder coating the structure. The pigtailed shall be coiled and secured in a manner that prevents damage during construction and while in transit. Cases shall have two 48-inch long No. 2 ground wires cadwelded to floor frame of the house at each end.
- B. Supply and install grounding material as specified in Section 34 42 56, Signal Grounding.

## **2.10 INTERNAL WIRING**

- A. Wiring shall be in accordance with Section 34 42 16, Signal Wires and Cables.
- B. Minimum wire conductor sizes shall be as shown on the Contract Plans unless otherwise approved by the Engineer.
- C. Adhering to minimum wire size specifications does not relieve the Contractor's responsibility of using wire sized large enough to safely and effectively provide power to the circuit it serves.

- D. Solderless terminals for stranded wire shall be in accordance with Section 34 42 60, Signal Systems Miscellaneous Products.
- E. Solid terminal connectors shall be used for all short terminal jumpers.
- F. All WAGO connections, except No. 6 battery connections, shall use vinyl insulated pin terminal connections such as Thomas and Betts Pin Terminal, part number 14RB-47PT, or approved equal.

## **2.11 PAINTING - INSULATION**

- A. All instrument enclosures shall be furnished complete with a layer of rigid insulation on the walls, doors, and ceiling. Instrument houses shall have a minimum 2-inch thick layer of rigid closed cell foam insulation rated R13. Instrument cases shall have a minimum 1/2-inch thick layer of rigid closed cell foam insulation rated R3.3. Insulation shall be suitable for residential installation.
- B. The interior including the ceiling, walls, terminal boards, and shelves shall be finished with a primer and two coats of white latex enamel paint.
- C. All paint shall be fire-retarding type.
- D. Apply typical legend for control point houses, highway grade crossing houses and cases as indicated on the Metrolink Engineering Standards. Consult with manufacturer of house prior to paint application.

## **2.12 EQUIPMENT RACKS**

- A. Equipment racks shall be the manufacturer's standard for the type of equipment furnished and shall be sized according to the Contract Plans.
- B. Equipment racks shall include all necessary supports for wire and equipment.
- C. Secure equipment racks by bolts attached to a threaded mounting plate structurally secured to the floor of the house. Attach stabilizing straps to the top of the racks as needed. Racks and mounting shall be secure enough to withstand a seismic event as specified in Section 34 42 00, General Signal Requirements.

## **2.13 OTHER EQUIPMENT**

- A. Wiring Raceway (Wire Routing): Internal case wiring shall be contained within surface-mounted plastic raceway. Raceway shall be of a polycarbonate, low smoke type with a solid snap-on cover and flexible sidewalls. The sidewalls shall be of "finger" type construction allowing for insertion and removal of wire runs with terminations attached. The manufacturer shall determine sizes. Fill capacity shall not exceed 60 percent.
- B. Panel Board: Furnish a single-phase, three-wire 120/240 VAC, 60 Hz panel board for each house furnished under this Contract. Size panel board as shown on the

Contract Plans. The capacity rating shall be in accordance with the Contractor's load calculations and the Contract Plans.

- C. Service meters shall conform to local codes.

## **2.14 GALVANIZED HOUSE FOUNDATIONS**

- A. All houses shall be equipped with telescoping foundations as described in Part 2.01 Q of this Section complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Section 34 42 60, Signal Systems Miscellaneous Products, and AREMA C&S Manual, Part 15.3.1.
- B. Galvanized steel foundations for cases shall be constructed of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4-inch steel plate.
- C. Bolt spacing shall be to manufacturer's standards for the equipment to be supported by the foundation.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Mount houses and cases level and plumb and secure thereon with the hardware provided. Do not use shims, spacers, or other filler devices to level and plumb houses or cases.
- B. Install cable entrance pipes through the cable knockout holes provided in the floor of the house behind the terminal board(s) as shown on Contract Plans. Fill pipes with a substance designed for the purpose that prevents entrance of debris, rodents, and other pests.
- C. Ground houses as specified in Section 34 42 56, Signal Grounding.
- D. Locate house as indicated on the Contract Plans. If conditions do not allow placement as shown on the Contract Plans, submit alternate placement for Engineer's approval.
- E. Install relays on the relay plugboards corresponding to the relay nomenclature and identification plate, and securely fasten in place with the hardware provided by the relay manufacturer.
- F. Place batteries on rubber matting on the floor of the shelter or bottom shelf of the case. Coat battery posts with approved grease and securely fasten battery connectors to the battery posts. Strap batteries or otherwise secure using a method approved by the manufacturer so that they will not tip or move in the event of an earthquake.
- G. Mark each grade crossing warning device case or shelter with the street name, milepost location, emergency response number, and DOT inventory number per Metrolink Engineering Standard 8270.



- H. Install pullboxes and conduits. Provide slotted pullbox covers to accommodate the cable chute at new house locations. Place the house so the chute aligns with the slotted cover.
- I. Make any modifications to the cable chute required to fit the pullbox and accommodate the cable installation. If it is necessary to cut the cable chute, ensure no rough edges, sharp edges, burrs, or other surfaces exist which have the potential to injure the cable.
- J. Install foundations, including telescoping foundations, for houses including Owner-furnished houses.

### **3.02 AC POWER**

- A. Wall mount load center as shown on the Contract Plans. Mounting height from floor, wire terminations, and clearances shall be in accordance with the NEC.
- B. Install service meters as described in Section 34 42 62, Service Meters.

### **3.03 FIELD QUALITY CONTROL**

- A. Test the functioning of the equipment contained within the instrument house in accordance with the requirements of Section 34 42 58, Signal System Testing, CFR Title 49, Parts 234 and 236, and AREMA C&S Manual Part 2.4.1.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Signal Equipment House with Contractor-Owner furnished foundation (Includes ground rods and grounding) 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. Signal Equipment House 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.

- C. Work of this Section shall include the cost of furnishing and installing foundations for the house, ground rods and grounding, including the cost of excavation, shoring where necessary, potholing, fill and any other equipment necessary to install a foundation and a ground system including any mounting hardware.

**END OF SECTION**

**SECTION 34 42 48**  
**POWER SWITCH AND LOCK MOVEMENT**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This section includes requirements for dual control switch and lock movement for each interlocked track switch at new, relocated and replaced switch locations as shown on the Contract Drawings.
- B. Refer to Division 34 72 00, Trackwork, for track construction requirements.

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices.
- B. Southern California Regional Rail Authority (Metrolink) Engineering Standards

**1.03 SUBMITTALS**

- A. Submit installation drawings showing the tie straps and the mounting details of the switch and lock movement, including the connections to the track switch points and target.
- B. Submit Acceptance Test documentation on power switch and lock movement prior to shipment of the movements.
- C. Submit copies of all field test reports.
- D. Submit temporary point protection plans to the Resident Engineer for review and approval.

**1.04 QUALITY ASSURANCE**

- A. Power switch and Lock Movements shall meet the recommendations of AREMA C&S Manual Part 12.2.1, where they do not conflict with any requirements specified herein.
- B. The Contractor shall coordinate the installation of Power Switch and Lock Movements with the track panel procurement and installation to ensure compatibility between the track panel and the switch machine. Incompatibility deriving from orientation, rod connections, or switch machine mounting is the responsibility of the Contractor and shall be corrected at no expense to the Owner.

- C. Switch machine orientation (left or right hand) shall be the same configuration as provided by the manufacturer. The Contractor is prohibited from changing this orientation without written authority from the Resident Engineer.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Protect Switch and Lock Movements and their component layout parts against damage during handling and shipment.
- B. During storage, properly lubricate and maintain switch and lock movement layouts on a regular timed program.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. Install all new and complete dual control Power Switch and Lock Movement layouts, including the switch targets where applicable. Power Switch and Lock Movement shall lock the switch points in power and hand operation. Power Switch and Lock Movement shall be 110VDC such as the Hitachi Rail STS (formerly Ansaldo STS USA) M23A configuration. The gear ratio shall be 360:1.
- B. Contractor furnished junction box shall be Model 1236-256 manufactured by Western Cullen Hayes, or an approved equal.
- C. Provide and install an insulated front rod per Metrolink Engineering Standards as part of the power switch layout.
- D. Miscellaneous Fittings: The Contractor shall provide all connectors such as threaded nipples, cable clamps, flex wire, tags, terminals and electrical fittings as required for each power switch and lock movement layout including 48-inch-long 2-inch-diameter liquid tight flexible conduit and connectors from movement to junction box.
- E. Switch targets shall be provided and installed by the Contractor within power switch machines where freight operations will be using the switch as a hand throw during construction of the project. Switch targets shall be removed when the power switch machine is placed into service.

### **2.02 SECURITY**

- A. Install SCRRA furnished switch padlocks on trainman's access side of hand-throw levers of power switch machine when the switch has been determined necessary for freight operations to access. Power switch machine will be placed in an inoperative mode (all power removed from machine) and hand throw levers padlocked in hand throw position with SCRRA provided switch locks.
- B. At power switches under construction and not to be used by the Freight Carrier, the Contractor shall place the power switch and lock movement in an inoperative mode (all power removed from machine and hand throw lever padlocked in hand

position) and switch points secured using a padlock able switch point clamp with Contractor provided padlock. All locks shall be Contractor provided.

- C. Furnish padlocks, except for switches requiring Freight Carrier access, until all systems have been accepted. At final acceptance, the Contractor will remove their padlocks and SCRRRA maintenance will furnish replacement padlocks.

### **2.03 SOURCE QUALITY CONTROL**

- A. Test each switch and lock movement before shipping it to the job site. Conduct this acceptance testing in accordance with the Contractor's Acceptance Test Procedure for switch and lock movements. Submit a copy of documentation of acceptance testing to the Engineer prior to shipping.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Mount and adjust the complete Switch and Lock Movement layout as specified herein and as indicated on the Contract Drawings.
- B. Wire control and indication circuits for power-operated switches as shown on the Contract Drawings.

### **3.02 INSTALLATION**

- A. Prior to installation, coat all parts of the switch and lock movement that are not painted, or made of non-corroding material with an approved grease to prevent corrosion. Suitably plug or cap unused threaded outlets.
- B. Where existing concrete ties are not used, install two 14 foot long timber ties for mounting the switch mechanisms as shown on the Contract Drawings. If a helper assembly is required, one of the switch mounting ties shall be 16 foot long.
- C. Prior to mounting the switch mechanism on either concrete or timber ties, align the switch headblock ties at right angles to the straight stock rail, and space the ties in accordance with the Metrolink Engineering Standards, and condition the switch points to move without binding.
- D. Provide and install all required components needed including, but not limited to, bolts, ties, gauge plates, universal plates, rods, switch point rollers and the Power Switch and Lock Movements at the locations shown on the Contract Drawings to produce a complete power switch installation.
  - 1. Secure power switch and lock movement to the switch ties using galvanized or cadmium plated bolts of the proper diameter. Bolts are required to have a six sided or square head and a head bolt lock must be used on the underside of the wood tie. All thread threaded rod is unacceptable.

- E. Install the Switch and Lock Movements at the locations shown on the Contract Drawings.
  - 1. Secure Switch and Lock Movement to the switch ties using (8) eight 7/8-inch bolts.
- F. Remove any ballast necessary for the installation of each switch and lock movement layout and replace and tamp ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the Switch and Lock Movement layout. Remove ballast from between ties to allow unrestricted movement of switch rods.
- G. Make a preliminary adjustment of switch and lock layout at the time of installation and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of the functional test. Make final adjustments in conformance with the requirements of AREMA C&S Manual Parts 12.2.1 and 2.4.1, and the Metrolink Signal Maintenance Manual.
- H. Do not apply power to the motor until the switch machine has been fully lubricated, thrown, and adjusted in hand throw. There shall be no rubbing or binding of switch rods or points on gauge plates, rails or ties. Follow manufacturer's adjustment and installation procedure.
- I. During storage and after installation, properly lubricate and maintain switch and lock movement layouts on a regular timed program until accepted by the Engineer.
- J. Exercise care and ensure that the switches, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease, as acceptable to the Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.
- K. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Engineer. Thoroughly steam clean the plates to remove all oil or grease prior to application of the graphite. Periodically renew the protective coating until such time as the Owner assumes responsibility for maintenance of the equipment.
- L. Removal of switch targets, if applicable, shall be the responsibility of the Contractor after in-service testing has been completed and control point is placed in service.

### **3.03 SECURITY**

- A. Install Owner-furnished switch padlocks on trainman's access side of electric locks, and power and hand throw levers of switch and lock movements.

### **3.04 TOUCH-UP**

- A. Touch-up the finish of equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Color shall match factory finish.

**3.05 FIELD QUALITY CONTROL**

- A. Inspect each switch and lock movement after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Inspection Procedure as accepted by the Engineer.
- B. Conduct final operational tests of switch and lock movements as described in Section 34 42 58, Signal System Testing.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

- A. Power Switch and Lock Movement 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, shall be determined from the actual count in units as designated in the schedule of Quantities and Prices.

**4.02 PAYMENT**

- A. Power Switch and Lock Movement 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 34 42 50**  
**SWITCH CIRCUIT CONTROLLER**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for Switch Circuit Controllers.
- B. Switch Circuit Controller and layout shall be all new and include the controller unit, junction box, point lug, detector rod, shims, all required bolts, nuts, washers, pins, grease fittings, cotter keys, vent elbows, plates, adjusting brackets, and all hardware to mechanically couple the switch circuit controller to the track switch points, as a stand-alone unit or in conjunction with an electric switch lock.
- C. Refer to Section 34 72 00, Trackwork, for track construction requirements.

**1.02 GENERAL**

- A. Switch Circuit Controller layouts shall include the controller unit, junction box, point lug, detector rod, shims, all required bolts, nuts, washers, pins, grease fittings, cotter keys, plates, adjusting brackets, and all hardware to mechanically couple the switch circuit controller to the track switch points and mount it on the ties.

**1.03 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
  - 2. Southern California Regional Rail Authority (Metrolink) Engineering Standards

**1.04 SUBMITTALS**

- A. Submit installation drawings showing the tie straps and the mounting details of the switch circuit controller, including the connections to the track switch points.
- B. Submit Contractors Acceptance Test Documentation on Switch Circuit Controllers prior to transport.
- C. Submit copies of all field-test reports.
- D. Submit temporary point protection plans to the Resident Engineer for review and approval.

**1.05 QUALITY ASSURANCE**



- A. Switch Circuit Controllers shall meet the recommendations of AREMA C&S Manual, Part 12.1.1, for a four front/back contact configuration where they do not conflict with any requirements specified herein. Mounting details shall conform to the Metrolink Engineering Standards.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Protect switch circuit controllers and their component layout parts against damage during handling and shipment.
- B. During storage, properly lubricate and maintain switch circuit controller layouts on a regular timed program.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. Furnish Switch Circuit Controller layout complete with rod, lug, and associated hardware as designated as required for a fully functional system.
- B. The Contractor provided Switch Circuit Controller and layout shall be Model U-5 with return spring, ventilators and wire outlet as manufactured by Hitachi Rail STS (formerly Ansaldo STS USA) or approved equal. Switch Circuit Controller provided by Contractor shall be complete with offset crank, operating rod, switch point lug and associated hardware.
- C. Contractor furnished Junction Box shall be Model 091 428-ABX manufactured by Siemens Systems or an approved equal.
- D. Furnish Insulated Vertical No. 1 Rod with Basket in accordance with Metrolink Engineering Standard 8660.
- E. Furnish Insulated Front Rod in accordance with Metrolink Engineering Standard 8650.
- F. Miscellaneous Fittings: Furnish all connectors such as threaded nipples, cable clamps, and electrical fittings as required for each Switch Circuit Controller layout including 24-inch-long two-inch-diameter flexible conduit and connectors from Switch Circuit Controller to junction box.

### **2.02 GENERAL**

- A. Stranded wire: Furnish insulated No. 10 AWG stranded wire between the pedestal-mounted junction box and the switch circuit controller. Insulated wire shall be in accordance with Section 34 42 16, Signal Wires and Cables.
- B. Miscellaneous Fittings: Furnish all connectors such as threaded nipples, cable clamps, and electrical fittings as required for each switch circuit controller layout.

### **2.03 SECURITY**

- A. Padlocks will be furnished by the Contractor until final acceptance.
- B. At new switches under construction that are not to be used by a freight carrier, the Contractor shall ensure that the switch points are secured using a padlock able switch point clamp with Contractor provided padlock. All locks shall be Contractor provided.

## **2.04 SOURCE QUALITY CONTROL**

- A. Test each switch circuit controller before transporting it to the job site. Conduct this acceptance testing in accordance with the Contractor's Acceptance Test Procedure for Switch Circuit Controllers.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Mount and adjust the complete switch circuit controller layout as specified herein and as indicated on the Contract Drawings and in accordance with the Metrolink Engineering Standards.
- B. Circuits for switch circuit controllers shall be as shown on the Contract Drawings.

### **3.02 INSTALLATION**

- A. Prior to installation, coat all parts of the Switch Circuit Controller that are not painted, or made of non-corroding material, with an approved grease to prevent corrosion. Suitably plug or cap unused threaded outlets.
- B. Install one 10-foot long timber tie or concrete tie for mounting the controllers as shown on the Contract Drawings
- C. Mount controllers on new and existing timber or concrete ties in conformance to Metrolink Engineering Standards.
- D. Dap and drill timber ties to meet the requirements of these Specifications. Limit of cutting or dapping shall not exceed 2 inches.
- E. Secure the Switch Circuit Controller to the wood switch ties, by 3/4 inch by 10 1/2 inch bolts. Secure switch circuit controller to the switch tie using galvanized or cadmium plated bolts. Bolts are required to have a six sided or square head and a head bolt lock must be used on the underside of the wood tie. All thread threaded rod is unacceptable.
- F. Remove any ballast necessary for the installation of each hand throw switch layout and replace and tamp the ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the Switch Circuit Controller layout.

- G. Make a preliminary adjustment of the controller layout at the time of installation and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of the functional test. Make final adjustments in conformance with the requirements of AREMA C&S Manual, Parts 12.1.1 and 2.4.1.
- H. Underground cable terminating in the controller junction box shall be dressed and pot headed as specified in Section 34 42 16, Signal Wires and Cables. Fan the individual conductors in a neat workmanlike manner, properly tagged and terminated. Wiring between switch junction box and switch circuit controller shall be No. 10 AWG insulated stranded flex wire. These wires shall also be tagged and terminated. Install the wires between the controller junction box and the controller mechanism in an approved flexible conduit with a minimum length of 10 inches and a maximum length of 21 inches. Fasten this flexible conduit to the switch junction box and switch mechanism with appropriate connectors.
- I. After installation, properly lubricate and maintain Switch Circuit Controller layouts on a regular timed program until accepted by the Engineer.
- J. Exercise care and ensure that the controllers, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease, as acceptable to the Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.
- K. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Engineer. Thoroughly steam cleaned the plates to remove all oil or grease prior to application of the graphite. Periodically renew the protective coating until such time as the Owner assumes responsibility for maintenance of the equipment.
- L. Connect switch circuit controller rods to the normally closed switch point. In cases where the switch circuit controller is being used with a sliding derail with wheel crowder (hand-throw derail application), connect switch circuit controller to the lug provided with the derail.
- M. Any switch assembly which is connected to the open point side, or which has a reverse switch indication, shall be equipped with an insulated front rod.

### **3.03 SECURITY**

- A. Install Owner-furnished locks on trainman's access side of electric locks and hand-throw levers of switch stands unless switch is being used for freight operations.

### **3.04 TOUCH-UP**

- A. Touch-up the finish of all equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Touch-up shall match factory finish.

### **3.05 FIELD QUALITY CONTROL**

- A. Inspect each Switch Circuit Controller after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Inspection Procedure as accepted by the Engineer.
- B. Conduct final operational tests of Switch Circuit Controllers as described in Section 34 42 58, Signal System Testing.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Switch Circuit Controller 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. Switch Circuit Controller 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 34 42 52

### RECTIFIERS, BATTERIES AND BATTERY CHARGING EQUIPMENT

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. This Section includes requirements for Rectifiers, Batteries, and Battery Charging Equipment.
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 34 42 58 – Signal Systems Testing

##### 1.02 REFERENCES

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- B. Southern California Regional Rail Authority (Metrolink) Engineering Standards
- C. Metrolink Signal Maintenance Manual

##### 1.03 DESIGN REQUIREMENTS

- A. Calculate the loads based upon the equipment proposed. Size all batteries to provide a minimum 48-hours standby capacity for all systems based on normal operating conditions. Verify the ampere-hour capacity shown on the Contract Plans is adequate to provide a minimum of 48 hours standby capacity.
  - 1. Size battery to provide a minimum of 48 hours of uninterrupted power to the signal systems at the normal operating load.
- B. Size batteries which provide power for crossing warning devices, such as gates and flashing lights, to provide 12 hours of continuous operation with the gate arms in the horizontal position and all lights flashing.

##### 1.04 SUBMITTALS

- A. Load calculations of each dc and ac load. Submit calculations identifying normal and worst-case conditions for each load.

**PART 2 - PRODUCTS****2.01 ACCEPTABLE MATERIALS**

- A. Exide ELM IRONCLAD Single Wet Cell low maintenance Lead Acid Batteries conforming to AREMA C & S manual parts 9.1.4 and 9.1.30 such as:
  - 1. Model (ELM 240, 240AH)
  - 2. Model (ELM 340, 340AH)
  - 3. Model (ELM 425, 425AH)
- B. Battery Charger: Charger conforming to the requirements specified herein as manufactured by National Railway Supply, or approved equal.
  - 1. Model HF-Max Battery Charger equipped with four (4) 12VDC, 20 amp modules part no. 12-4-310-10-D.
  - 2. Model HF-Max Industrial Switch Mode Battery Charger and Supply part no. BBX0410DAGIX00.
- C. Battery Charger – manufactured by NEWMAR.
  - 1. Model SPS-12-20A, or approved equal.
- D. VMI Battery Charger – shall be all new and as manufactured by Quality Marine, or approved equal.

**2.02 EQUIPMENT DETAILS**

- A. Battery charging equipment shall be designed for continuous operation.
- B. Battery charging equipment shall be designed to deliver rated outputs with input voltage of 100 Vac to 130 Vac at 60 Hz, single phase, two wire input.
- C. Battery charging equipment shall have a reserve capacity of at least 25 percent above the calculated high load requirements.
- D. Each charger shall be provided with programmable output voltage adjustment.
- E. Terminal markings for ac and dc terminals shall be permanent.
- F. The charger shall provide a stabilized output voltage, temperature compensated with output current limiting. The capacity of the battery charger shall be determined by the Contractor and approved by the Engineer. The charger shall adjust its output current automatically, according to the load and to the demand on the battery.

- G. Battery charger shall conform to requirements in AREMA C&S Manual Part 9.2.1. The output of the charger shall be sufficiently filtered to be compatible with the input voltage requirements of the solid-state interlocking units, and all other electronic equipment for the signaling system.
- H. Battery Cells shall be square tubular type design, flooded lead acid. Individual battery cells shall have handles incorporated into their design to facilitate lifting.
- I. Batteries shall not release any gas, fumes, or any toxic substances when operated under normal conditions or when charged or discharged at a maximum recommended rate. Each battery cell shall be equipped with a dual action bayonet type flame-arresting vent plug, having an integral electrolyte level gage.
- J. Batteries shall be capable of a minimum of 1,500 charge-discharge cycles to 80 percent discharge without loss of capacity. Totally discharged batteries, even if polarity has reversed, shall be capable of being recharged to rated capacity with charging voltage of no more than 2.30 volts per cell. Contractor shall warrant that all batteries supplied shall be free from any defective workmanship or faulty materials for a period equal to, or greater than, twenty (20) years, ten (10) full years of coverage plus ten (10) full years of pro-rata coverage. The Engineer reserves the right to reject any bid that fails to comply with these Specifications.

### **2.03 MISCELLANEOUS MATERIALS**

- A. Furnish all mounting hardware, terminals, and terminators, and similar items for mounting chargers and batteries in wayside cases and signal instrument shelters.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Install batteries and battery charging systems as shown on the Contract Plans.

### **3.02 TESTS**

- A. Perform tests specified in Section 34 42 58, Signal Systems Testing, ensuring system operation.
- B. Test batteries and battery chargers in accordance with the manufacturer's and the Metrolink Signal Maintenance Manual's instructions.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

- A. Rectifiers, Batteries, and Battery Charging Equipment 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. Rectifiers, Batteries, and Battery Charging Equipment 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 34 42 52**



## **SECTION 34 42 54**

### **RAIL BONDING**

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

##### **1.01 SUMMARY**

- A. This Section includes requirements for rail bonds, fouling bonds, frog bonds, track circuit connections, and all other material required for bonding of track circuit joints, track frog and switch bonding, and track circuit connections.

##### **1.02 SYSTEM DESCRIPTION**

- A. Rail Bonding and track connections shall be in accordance with the Metrolink Engineering Standards.
- B. Rail track joints shall be bonded with welded railhead bonds per the Metrolink Engineering Standards.
- C. Track switch, frog fouling bonds, and track connections shall be stranded bonds.
- D. Crimped sleeves shall not be used for any fouling or frog bonding unless allowed by the Engineer.

##### **1.03 SUBMITTALS**

- A. Product Data: Manufacturer's catalog cuts, material specifications, installation and maintenance instructions, and other data pertinent to the bonding material, staples, and circuit connections, specified herein and as shown on the Contract Plans.

#### **PART 2 – PRODUCTS**

##### **2.01 MATERIALS**

- A. Rail Head Bonds: Railhead bonds shall be 3/16-inch in diameter with steel terminals welded to the conductors. They shall have a nominal length of 6 1/2 inches.
- B. Web Bonds: Web Bonds shall be 3/16-inch, 12-inch long welded to the web.
- C. Track Circuit Rail Connectors: Track circuit connectors shall be 3/16-inch stranded bronze conductor, 1-inch tap for welded connection on one end and compression sleeve on the other end for a direct crimp type connection to the track wire and shall have a nominal length of 4 inches. Use no crimped connections on fouling wires or frog bonding unless authorized by the Engineer.
- D. Bond Strand: Bond strand for fouling wires shall be 3/16-inch single strand with 4/16-inch black PVC insulation.

- E. Acceptable Manufacturers:
  - 1. All electrical connections to rail shall be welded with the CADWELD® copper-based exothermic welding process as manufactured by ERICO Products or approved equal.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION OF WELDED BONDS**

- A. Install welded bonds at all non-insulated rail joints within the limits of this Contract that are not equipped with a bond.
- B. Grind clean with a vitrified grinding wheel the surfaces of the rails where the bond is to be applied. After grinding, clean surface with an approved non-toxic solvent to remove all traces of grease and dirt. After the surface has been ground and cleaned, weld the bond wire to the rail in a manner that will ensure a thorough mechanical and electrical connection.
- C. Before beginning work on these bonds, weld in the field, under conditions like those of the regular installation, not less than three complete bond connections, and as many more as the Engineer considers necessary to determine that the welds are being made satisfactorily. Such welds shall be subject to inspection and testing by the Engineer, and acceptance as to the method and quality of workmanship will depend on the results of these inspections and tests.
- D. Ensure that each bond connection is thoroughly welded to the rail. The Engineer reserves the right to require a test of each weld by hammer and striker, or in any other manner, which in the opinion of the Engineer is reasonable.
- E. Remove any welded bond installed by the Contractor that is found to be defective prior to acceptance and install a new bond.
- F. All welded bonds shall be installed per manufacturer's recommended installation procedure.

#### **3.02 INSTALLATION OF TRACK CIRCUIT CONNECTIONS**

- A. The plug end of the track circuit connector shall be as specified herein, at a maximum distance of 3 inches from the end of the insulated joint. When there are multiple track connections to be applied at an insulated joint the wayside signal track connection shall be the nearest connection to the insulated joint with crossing detection circuits next and crossing shunts lastly installed in this order. The Contractor shall ensure that the insulating quality of the materials used to protect the splice meets FRA 234.241 requirements. The use of compression sleeves for track circuit connections is only acceptable when making a bond strand connection to underground cable inside of the trackside concrete pull box.
- B. Strip back underground cable a sufficient distance for the exposed conductor to be fully inserted into the compression sleeve. Then compress sleeve with the type of compression tool designed for that purpose.

- C. Track wire installation shall conform to the SCRRRA Engineering Standards.
- D. Install all track circuit connections. Remove any found to be defective prior to acceptance and install a new track circuit connection.
- E. Provide and install bond strand retainer clips made of Electroplated Spring Steel on the rail base to hold terminated bond strand in place as specified in the Metrolink Engineering Standards and as recommended by the manufacturer.
- F. Provide and secure the bond strand along the tie by use of PVC cable keeper for wood ties or “Snap-On” Style Stainless Steel Concrete Tie Clips for concrete ties.

### **3.03 TESTING**

- A. Shunt test all track circuits for continuity of circuit and ensure main line track circuit is de-energized with 0.06-ohm shunt at any point within the track block. Hardwire shunt usage for inspection and certification of wayside track circuits and constant warning devices is unacceptable.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Rail Bonding 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. Rail Bonding 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 34 42 56**  
**SIGNAL GROUNDING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for a grounding system for the equipment shelter and all other wayside equipment apparatus.

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- B. Southern California Regional Rail Authority (Metrolink) Engineering Standards
- C. ASTM International (ASTM):
  - 1. B8 - Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- D. National Fire Protection Association (NFPA):
  - 1. 70 - National Electrical Code (NEC)

**1.03 SUBMITTALS**

- A. Submit drawings showing the design and detail of the proposed grounding system for the signal and power equipment proposed to be furnished and installed.
- B. Submit catalog cuts or drawings showing the type of components to be used for the proposed grounding system(s).
- C. Submit Installation and Test Procedure proposed for all equipment grounding.
- D. Submit test reports to the Resident Engineer upon completion of testing of a location.

**1.04 QUALITY ASSURANCE**

- A. Materials and equipment furnished and installed under this Section shall conform to all applicable State and local ordinances pertaining to electrical power installations and the National Electrical Code (NEC)

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. Ground rods shall be copper-clad stainless steel, in accordance with AREMA C&S Manual Part 11.3.4. The rod shall be at least 10 feet in length and at least 3/4-inch diameter.
- B. Ground rod clamps shall be made of a cast bronze clamp body, with non-ferrous set-screws in accordance with AREMA C&S Manual Part 11.3.4.
- C. Internal ground wire, from the equipment to the ground bus, shall be insulated No. 6 AWG standard copper wire in accordance with AREMA C&S Manual Part 11.4.1. Insulated ground wire shall be colored green.
- D. Provide a grounding bus of nickel-plated hard drawn pure copper in the equipment shelters sized appropriately for the connections involved.
- E. Bare Ground Wire: Soft drawn copper, Class A or Class B stranded, shall meet the requirements of ASTM B8. Sizing of ground wire shall be in accordance with the NEC, except where sizes specified herein or shown on the Contract Plans are larger than those required by NEC; UL listed, Label A for lightning protection conductors. Grounding cable shall be continuous without joints or splices throughout its length.
- F. Bolted Grounding Connectors: Use connectors made of high strength electrical bronze, with silicon bronze clamping bolts and hardware in accordance with AREMA C&S Manual Part 11.3.4; designed such that bolts, nuts, lock washers, and similar hardware which might nick or otherwise damage the ground wire, shall not make direct contact with the ground wire.

### **2.02 MATERIALS**

- A. Ground rods: As manufactured by Copperweld Corp. or an approved equal.
- B. Ground wire as specified herein.
- C. Cadweld connections: As manufactured by Erico Corp. or an approved equal.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. General
  - 1. Ground the following as described herein and in accordance with the applicable requirements of the National Electrical Code (NEC) and local city electrical codes: Service equipment, motor frames, switchgear and equipment enclosures, lighting and power panelboards, transformers, raceways, fences and gates, building or structure steel frames, lighting standards, floodlight poles, and power/light pull boxes/maintenance holes.

2. The grounding system shall preclude any closed loop grounding arrangements.
3. Do not ground connection(s) to the track rails; do not use the neutral conductors of the ac power supply.
4. Grounding under these specifications shall conform to AREMA C&S Manual Part 11.4.1. In cases where these instructions differ, the Engineer will make final determination.
5. Ground wire/cable runs shall be as short and straight as possible and shall not be interrupted by any device, termination or splice.

B. Exterior: Equipment Shelter Grounding

1. At equipment shelters, drive four ground rods into the ground, one near each corner of a structure. At equipment cases, drive two ground rods into the ground, at opposite corners of the structure. The ground rods shall be a minimum of 6 feet apart and shall be driven below ground level. Dig a 12 inch deep trench between the ground rods. Electrically connect each of the ground rods connected to the others, using a No. 2 AWG bare stranded copper cable, welded using Cadweld or an equivalent thermal process. Coat Cadweld connections with epoxy resin. Place the ground wires in the bottom of the trench. Backfill trench, returning the soils removed during construction of the trench.
2. Cadweld shelter's copper ground cables to the ground rods.
3. Ground resistance, as measured by the "Fall-Of Potential" method, shall not exceed 15 ohms.
4. Where flexible conduit is used, provide a bonding jumper.

C. Interior: Equipment Grounding

1. Equip shelters with a prime ground terminal securely attached electrically to the shelter structure and to the made ground network.
2. Run ground connections from lightning arresters and equipment chassis separately to ground buses in the shelters, as shown on Contract Plans. Connect ground buses to the prime ground with green insulated No. 2 AWG stranded wire.
3. Properly ground equipment that is powered by or switches voltages greater than 35 volts ac or dc.
4. Properly ground equipment that has conductors that leave the shelter.

**3.02 TESTING AND INSPECTION**

- A. Ground Resistance Testing: Verify that resistance between ground buses and absolute earth, as measured by the "Fall-Of Potential" method, does not exceed 15 ohms without benefit of chemical treatment or other artificial means.
- B. Test Reports: Provide test reports to the Engineer upon completion of ground tests that completely describe ground resistance test procedures and test results. Test reports shall be signed by a technician and witnessed by a representative of the Engineer.
- C. Prior to final acceptance by the Engineer, arrange to have the new ac power service inspected by state and local jurisdictional authority(s) as required.

**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. Full compensation for all ground rods and grounding systems shall be considered as included in the contract prices paid for the various items of work involved, such as case and house installation, signal installation and AC meter service installation and no additional payment will be made therefore.

**END OF SECTION**

**SECTION 34 42 58**  
**SIGNAL SYSTEM TESTING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for tests and inspections to demonstrate that systems, subsystems, assemblies, subassemblies, and components supplied and installed under this Contract comply with these Specifications and with all applicable regulatory and Owner requirements.
- B. Related Specifications include but are not necessarily limited to:
  - 1. Division 34 42 – Railroad Signals

**1.02 REFERENCES**

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
  - 1. Part 234 Grade Crossing Signal System Safety
  - 2. Part 236 Rules, Standards, and Instructions for Railroad Signal System
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- C. Southern California Regional Rail Authority (Metrolink) Engineering Standards
- D. Metrolink Signal Maintenance Manual

**1.03 TEST SYSTEM DESCRIPTION**

- A. It shall be understood where this Section states “as authorized by the SCRRA Signal Manager or SCRRA Signal Engineer” or “submit to the SCRRA Signal Manager or SCRRA Signal Engineer” such authorization or submittal shall be through the Resident Engineer or Project Manager.
- B. Tests and inspections shall be made both during the progress of this Contract and after completing installation of equipment and shall consist of factory tests of contractor furnished equipment, circuit breakdown tests, wiring verification tests, continuity tests, resistance tests, voltage and current tests, applicable locking tests, operating tests, simulation tests, and other electrical and mechanical tests and inspections.
- C. The work shall include all tests required to ensure proper and safe operation of all systems and subsystems, and to prove the adequacy and acceptability of the total



installation specified herein. Tests to be performed shall cause each system and subsystem to be sequenced through its required operations, including imposition of simulated conditions to prove that the installation complies with all specified fail-safe requirements.

- D. Each Contractor furnished component and unit of the wayside signal and highway grade crossing system shall have an inspection performed at its point of manufacture and evidence of this inspection and acceptability shall be indicated on the item where practicable.
- E. Conduct an acceptance test on all Owner furnished equipment prior to loading at the warehouse. Provide certified acceptance reports with each unit at time of delivery.
- F. Work shall include costs of the Contractor's personnel and any special equipment and assistance required to conduct all tests with complete documentation.
- G. Supply test equipment of proper type, capacity, range, and accuracy to perform required tests and inspections.
- H. Test equipment used shall be in good working order and properly calibrated within 6 months of the date of the tests. This equipment shall display a sticker, indicating its calibration date and the agency that performed the calibration.
  - 1. Calibration of each instrument shall be certified by a recognized testing facility. Instruments with out-of-date calibrations will be considered non-certified. Tests conducted with non-certified instruments will be rejected.
- I. If the system does not meet requirements, make necessary corrections and retesting. Complete all tests and inspections prior to performing final in-service tests.
- J. Work shall include all necessary disconnecting and reconnecting to perform the specified tests.
- K. Signal systems test work described elsewhere in these Specifications shall be construed as related to, and inclusive with, the testing described herein.
- L. Field tests shall be coordinated with the Engineer. As many tests and inspections as possible shall be completed prior to the final cutover to avoid train delay, inconvenience to the travel public, and cost to the Owner. Place systems in-service in phases where possible, thus reducing the actual cutover period.
- M. Tests shall ensure conformance with CFR 49, Parts 234 and 236, and shall be recorded on forms provided by the Engineer and signed by the Contractor's Signal Engineer directing each test and inspection.
- N. Tests and inspections shall conform to the Metrolink Signal Maintenance Manual. Owner will provide three (3) copies of this Manual at the Pre-Construction meeting. Refer to Section 01 31 00, Project Management and Coordination, Contract Meetings. Request guidance from the Engineer where the test and

inspection requirements written herein conflict with the Metrolink Signal Maintenance Manual. If the test or inspection, to be provided by the Contractor is not provided in the Metrolink Signal Maintenance Manual, the Contractor shall request in writing to the Resident Engineer instructions of the testing required.

- O. Testing, including pre-testing, shall include operating all switch machines and lighting all signals. The use of lamp simulators in lieu of, or in parallel with signal lamps will not be allowed in pre-testing. An exception may be authorized by the Resident Engineer where a signal or switch machine is in service and will be reconfigured for final cutover or cannot be installed or wired until final cutover.
- P. An appropriate meter shall be used when testing circuits. Visual observation of a relay is only valid when coil voltage or current or contact voltage, as applicable, is also measured.
- Q. Test and inspection procedures shall be subject to the Resident Engineer's acceptance and shall comply with all regulatory requirements and the manufacturer's recommended test procedure.
- R. Notify the Engineer in writing at least 48 hours prior to each field test. No part of the signal system shall be placed in service without an authorized representative of the Engineer being present and witnessing the in-service tests.

#### **1.04 SUBMITTALS**

- A. Submit the following pre-test information to the Resident Engineer for acceptance:
  - 1. Pre-testing authorization request 15 days in advance of proposed pre-testing. Such request shall include:
    - a. Names of Contractor's Signal Engineer in charge of pre-testing.
    - b. Other personnel assigned to the pre-test who will be performing the tests or assisting with the tests.
    - c. List the assigned location(s) of the Contractor's personnel and their designated duties during the pre-test.
    - d. An outline of the tests to be performed on each type of component, unit, or system, together with samples of the corresponding test records. The outline shall be arranged to indicate the proper sequence of each test to be performed on each component or unit. In addition, the date and time will be shown for each test.
    - e. Detailed description of each test to be performed, including the operating parameter to be tested. Test equipment to be used for the test, including the model number, serial number, calibration period, last calibration date and a brief description of the purpose of the test equipment.

- f. Description of equipment to be used for communication between the various individuals involved in the testing.
  2. Schedule of pre-testing Contractor proposes to perform which includes beginning and ending dates, times, and locations in a time-line format.
  3. Identify any test or operation that may disrupt or disarrange the existing signal circuits or systems. Include description of proposed safety provisions and back-up contingency plans.
- B. Submit the following in-service testing information to the Engineer for acceptance:
1. Submit, 60 days in advance of any in-service testing, a detailed cutover and in-service test procedure. This procedure shall indicate the Contractor's personnel involved, their assigned location, and responsibility during the in-service testing. Include the following for Contractor-directed signal cutovers (the following does not apply to Owner-directed signal cutovers): The test procedure shall adequately reflect the test to be performed and the sequence in which the tests shall be performed. A signal aspect chart indicating the appropriate signal aspect to be displayed as train simulation tests are made shall be included. The signal aspect chart shall indicate the progressive down grading of signals and track codes and shall reflect the resulting signal aspect displayed because of a light-out condition.
  2. The test procedure shall include an outline of the tests to be performed on each type of component, unit, or system, together with corresponding samples of test record forms and cards. The outline shall be arranged to indicate the proper sequence of each test to be performed on each component or unit; the numbers of each type of component or unit to be tested to demonstrate adequacy of design and quality control; and a line diagram showing the grouping and sequencing of system and subsystem.
- C. Contractor's testing procedures and cut-over plan is subject to the Resident Engineer's review and approval. Allow 30 days for this approval process. In the event the Contractor's testing procedures and cutover plan is rejected in any manner, the Contractor shall not be entitled to any claim for delay or compensation from the Owner.
- D. Record the results of each test, as herein specified, and submit copies of the field test reports to the Engineer immediately at the completion of the cut-over testing. Prepare final type-written test reports as indicated herein and submit to the Engineer within five (5) days after the completion of each test. Final type-written test reports shall include complete details of the test results and corrections, or adjustments performed, or which remain to be completed. The type-written test reports shall be signed and dated by the Contractor's Signal Engineer. Furnish certified test results for tests performed by any subcontractors when such tests are required within these Specifications.
- E. Where required in this Section, submit test results on completed SCRRRA test record forms.

- F. Submit test reports for any additional tests required by the Contractor to ensure the safe operation of the system to the Engineer.
- G. Upon completion of all tests, submit a letter certifying that all tests necessary to comply with all current regulatory requirements of these Specifications have been performed at listed locations.

### **1.05 QUALITY ASSURANCE**

- A. The Work and testing shall comply with the following standards and regulatory requirements: AREMA Communications and Signals Manual, Part 2.4.1. and CFR, Title 49, Parts 234 and 236.

## **PART 2 – PRODUCTS**

### **2.01 SITE TEST INSTRUMENTS AND EQUIPMENT**

- A. Test instruments and equipment necessary to conduct the tests specified herein shall be available, ready for use not less than one week in advance of test need. “Ready for use” shall mean properly matched for test parameters, properly calibrated, and sufficiently supplied with leads, probes, adapters, stands, and similar items necessary to conduct the test in a completely professional manner.

### **2.02 TEMPORARY TEST MATERIALS**

- A. Temporary or interim test related materials, special tools, connections, jumpers, and similar items shall be furnished and available not less than one week in advance of the test need.

### **2.03 FACTORY TESTS AND INSPECTIONS**

- A. All wiring and equipment shall be checked to verify conformance to the Contract Plans and the Specifications.
- B. Each control point, intermediate signal, grade crossing warning system shelter or any other signal equipment shelter shall be tested to verify that it functions properly before it is shipped to the field for installation. These tests shall involve connecting all control systems (excluding signals, switches, and similar equipment) that make up a control point, intermediate signal, grade crossing warning system shelter, or any other signal equipment shelter; applying power; and then exercising each function of the system and verify proper result.
- C. Provide confirmation that all required factory tests of systems, sub-systems, assemblies, sub-assemblies and components supplied under this Contract have been performed. Each component and unit shall be inspected at its point of manufacture and evidence of this inspection and acceptability shall be indicated. Certified test reports shall be furnished.

## **PART 3 - EXECUTION**

### 3.01 FIELD TEST PROCEDURES

- A. Perform as many pre-tests as possible in advance of in-service testing. Include, at minimum, the adjustment of tunable joint couplers, microprocessor based coded track circuits, verify signal aspects against received and transmitted codes. Verify operation of, calibrate grade crossing prediction units, and adjust grade crossing signal control equipment as required to assure proper operation. To have a successful cut-over, it is essential that as much pre-testing and advance wiring be completed before in-service testing begins.
  - 1. Condition precedent for in-service testing and cut-over will be the completion of pre-testing and the Resident Engineer's acceptance of the results. Complete pre-testing and submit the results to the Engineer not less than one (1) week prior to the proposed cut-over date.
- B. The field tests performed shall cause each installed system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions, to demonstrate that the installation complies with all specified fail-safe design requirements and operational functions.
- C. Demonstrate the quality of installation by field tests for continuity, insulation resistance, resistance of ground connections, circuit breakdown, visual inspection, and any other tests required by these Specifications. Perform these tests prior to any operational testing of systems or subsystems.
- D. The Contractor's test procedures shall consist of preprinted data sheets or inspection forms. Where applicable, results of test results shall be recorded on SCRRRA forms. These forms will be provided by the Engineer. When completed by the field test personnel and checked for accuracy and completeness, submit the sheet as the test report.
- E. When tests require specific meter or test instrument readings, the preprinted data sheet shall show the allowable range of values, for each part of the test. The test report shall also contain a check off system for each action and a blank space adjacent to the expected value in which to record the test readings.
- F. All test reports shall be dated and signed by the Contractor's Signal Engineer on the day the test is performed. Space also shall be provided for the signature of the witnessing inspector.
- G. The report shall show the specific test instruments used on each test, with instruments identified by name, type, serial number, calibration date, and calibration due date.
- H. Should an error be discovered during field testing due to field wiring and connections that do not agree with the accepted circuit plans, the Contractor may correct such errors without prior acceptance of the Engineer. The Contractor shall notify the Engineer of the corrections as soon as practical.

- I. The Engineer will make all final determinations as to whether only a part, or the whole test, shall be rerun when any specific field test does not meet the requirements specified for the test.
- J. Any changes made after completion of test procedure shall be re-tested in accordance with the applicable test procedure and regulatory requirement.

### **3.02 GENERAL FIELD TESTS AND INSPECTION**

- A. Perform general field tests including the tests listed herein.
- B. Ground verification test.
- C. Dielectric breakdown test of all vital circuitry.
- D. Wiring verification of all non-vital circuitry.
- E. Vital function tests.
- F. Operating tests.
- G. All applicable tests prescribed by AREMA C&S Manual Part 2.4.1, where the AREMA inspections and tests do not conflict with the requirements of these Specifications
- H. All applicable tests as required to ensure systems comply with CFR 49, Parts 234 and 236.
- I. Positive Train Control (PTC) verification and validation.

### **3.03 SPECIFIC FIELD TESTS AND INSPECTION**

- A. Perform specific field tests listed herein.
- B. Grounds:
  - 1. Ground resistance shall be tested and reported as described in Section 34 42 56, Signal Grounding.
  - 2. All low voltage DC circuits shall be tested for grounds in accordance with the Metrolink Signal Maintenance Manual.
  - 3. Contractor shall record test results on the appropriate SCRRA form and submit this completed form to the Engineer to obtain acceptance of this test requirement.
- C. Insulation Resistance:
  - 1. Insulation resistance tests shall be made between all conductors and ground, and between conductors in each cable in accordance with FRA rule 236.108. The insulation resistance of wires and cables installed by the

Contractor shall provide an “infinite” reading when using a direct reading instrument (megger) having a self-contained source of direct current test voltage. The megger scale shall have a minimum range of zero to 20 megohms and be rated at 250 volts minimum and 650 volts maximum.

2. All insulation tests shall be performed after the equipment and cables are installed and completely terminated in the field.
3. Contractor shall record test results on the appropriate SCRRA form and submit this completed form to the Engineer to obtain acceptance of this test requirement.

D. Vital Relays:

1. All DC vital relays shall be tested for pick-up and drop-away values. These values shall be in accordance with field requirement values stated in Table 641-1 of AREMA C&S manual, Part 6.4.1.
2. Contractor shall perform all tests in accordance with the Metrolink Signal Maintenance Manual. Results shall be recorded on the appropriate SCRRA test form.
3. These tests shall be performed at the shelter locations after the shelter has been set. Test result forms shall be submitted to the Resident Engineer.

E. Energy Distribution: Energy-Off Tests: With all power to the signal instrument shelter or wayside case off, the following checks and tests shall be performed. These tests shall include:

1. Removing all fuses.
2. Verifying that circuit breaker size compares to that of Contract Plans.
3. Comparing wire gages with those called for on the Contract Plans. All discrepancies in wire sizes shall be replaced with the proper size wire.
4. During energy distribution breakdown, a wire count on each terminal, relay contact, etc. shall be taken to ensure that only the number of wires called for on the Contract Plans is present at each terminal, relay contact, etc. Any discrepancies found shall be corrected and additional wires, if found, shall be removed.
5. Verify proper system voltage for each power supply, AC and DC.
6. Verify all power supplies for correct settings.
7. Verify that no cross, shorts, or grounds exist.
8. Tags shall be verified for proper nomenclature and terminal location.

## F. Breakdown of Control Circuits:

1. All circuits shall be tested in their entirety for the correct operation of, and response to, each contact on each circuit element, such as relays and contactors. Where parallel paths exist, the tests shall validate each path, and circuits shall be opened when required to ensure the proper test has been made.
2. Each circuit shall be tested by simulating all operating conditions to verify that the circuit operates in accordance with the Specifications and accepted plans.

## G. Electric Switch and Lock Movements (when applicable):

1. Continuity checks of field wires to switch-and-lock movements to verify all nomenclature.
2. Adjust throw bar so that proper tension is placed on switch points in both directions.
3. Manually operate switch machine normal and adjust lock rods and point detector rods to allow switch machine to lock up with no obstruction. Repeat above for switch machine in reverse position.
4. Turn on switch machine power, call switch machine normal and observe in field that switch machine corresponds to position called, and observe in wayside instrument shelter that proper switch correspondence relay is energized.
5. With switch machine called normal, check gaps on circuit controller contacts to see that they meet equipment specifications. Operate machine reverse and repeat.
6. Break down each contact in switch circuit controller and observe that proper switch correspondence relay drops. Repeat this procedure for both positions of the switch.
7. Place ammeter in series with motor control energy and adjust clutch such that it causes overload relay to pick up in less than ten seconds with 1/4-inch obstruction in switch point. Record current reading. Repeat for opposite position.
8. Place switch and lock movement in "hand" operation and observe switch mechanism cannot be operated by power. Place back in "motor" and verify that switch mechanism can be powered from wayside instrument shelter.
9. Operate switch, then shunt detector track circuit and observe that switch machine is stopped in middle of stroke and not allowed to complete movement. Remove shunt and verify switch completes movement.



10. Contractor shall record test results on the appropriate SCRRRA form and submit this completed form the Engineer to obtain acceptance of this test requirement.
- H. Signal Layouts: Tests shall be performed on all signal layouts. These tests shall include the following:
1. Continuity check of field wires and verification of all nomenclature.
  2. Apply energy to signal lighting circuits and adjust all lamp voltages to 10 percent less than the lamp rating.
  3. Sight signals for maximum visibility.
  4. Check that light-out feature, where used, complies with FRA Rule 236.23(f).
  5. Positive Train Control (PTC) verification and validation. Demonstrate that signal aspects are tabled correctly into the Metrolink PTC system. Test shall be performed in coordination with Metrolink assigned personnel. All possible signal aspects shall be verified and confirmed against the applicable Metrolink database.
- I. Line Circuits: The purpose of this test procedure shall be to verify the integrity of line circuits between wayside instrument locations. These tests shall include the following:
1. All nomenclature shall be verified and line circuits tested for continuity.
  2. Each repeater relay shall be tested to determine that it follows the primary relay's operation.
  3. Each line circuit will have a breakdown test performed between wayside instrument locations. Breakdown of the line circuit shall begin at the origination point of the circuit. The positive side of the circuit shall be opened to ensure appropriate relay or input is de-energized in the other instrument shelter. Close circuit and verify that the proper relay returns to its normal position. Repeat for the negative side of the circuit. If circuit breaks through relays within the instrument shelter where circuit originates, drop each relay one at a time, which breaks the circuit to verify that the appropriate relay or input is de-energized in the other instrument shelter. Restore relay and verify that the proper relay and/or input returns to its normal position in the other shelter. Each relay and/or input shall be tested to ensure that it follows all the proper breaks in the signal shelters.
- J. Control Office to Wayside Interface (when applicable): Upon completion of the wayside tests, a system test shall be performed to ensure continuity of operation of wayside equipment by the supervisory control system. This test shall consist of controlling all office wayside functions from the supervisory control console and the transmission back to the control office of all indications from the field stations. The functions to be tested shall include the following:

1. Controls from Supervisory Control Console
    - a. Control of switch machines.
    - b. Lining of routes.
  2. Indications to Supervisory Control Console
    - a. Switch machine positions normal, reverse and out-of-correspondence.
    - b. Track circuit occupancy, all tracks.
    - c. Signal clear indications, each signal.
    - d. Power-off and alarm indications.
    - e. Auxiliary input indications if applicable.
    - f. Signal at stop indications, each signal.
    - g. Signal in time indication for each route.
  3. All design changes found necessary to obtain proper operation shall be submitted to the Resident Engineer for acceptance.
- K. Local Panel Test (when applicable):
1. Verify proper operation of all controls and indications.
- L. Switch Circuit Controllers (when applicable):
1. Each switch circuit controller shall be tested to verify wiring, mechanical connectors, point obstruction, and point detection in accordance with AREMA C&S Manual, Part 12.5.1.
  2. Contractor shall record test results on the appropriate SCRRA form and submit this completed form to the Engineer to obtain acceptance of this test requirement.
- M. Track Circuits:
1. Each track circuit shall be tested for shunting sensitivity and polarity in accordance with the AREMA C&S Manual, Part 8.6.1.
- N. Insulated joints:
1. Each insulated joint installed by the Contractor shall be tested with one of the following insulated joint testers, the Harmon 1501A1JC, S&C Model 324 Track Circuit Short Finder, or accepted equal, and shall measure no less than 100 ohms across the joint.

- O. Interlocking and Control Point Tests (when applicable):
1. A detailed list of the tests and complete test procedures shall be provided by the Engineer to establish safe and proper operation of interlockings. The Contractor shall provide the necessary personnel and equipment, along with support functions, as part of the signal test crew. The test sequence shall be designed to test each function for correct performance, in accordance with these Specifications and the Contract Drawings. Furthermore, the test sequence shall include simulated unusual conditions to determine that the interlocking circuits will respond in a safe and desirable way.
  2. The functions to be tested shall include the following:
    - a. Time locking.
    - b. Route locking.
    - c. Verification of time releases.
    - d. Indication locking.
    - e. Signal operation in accordance with route and aspect charts.
    - f. Positive Train Control (PTC) verification and validation.
    - g. Interconnection with existing block signal systems.
    - h. Interconnection with existing interlocking's. With an established direction of traffic, the controlled signal, governing entrance to that route, shall be put to stop. Traffic in the opposite direction shall not be established until a predetermined time has passed. This predetermined time shall be as indicated on the accepted plans. It shall be ascertained that time locking is effective for this test.
  3. Time tests shall be as follows:
    - a. Loss of shunt.
    - b. Time locking.
    - c. Flashing rate time.
  4. Positive Train Control (PTC) verification and validation. Demonstrate that signal aspects and power switch positions are tabled correctly into the Metrolink PTC system. Test shall be performed in coordination with Metrolink assigned personnel. All possible signal aspects and switch positions shall be verified and confirmed against the applicable Metrolink database.

5. Record test results on the appropriate SCRRA forms. Submit these completed forms to the Engineer to obtain acceptance of these test requirements.

## **PART 4 – MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Signal System Testing 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. Signal System Testing 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 the cost of all associated equipment, including meters, meggers, relay test units, shunt cords, communications equipment and testing.

**END OF SECTION**

**SECTION 34 42 60**  
**SIGNAL SYSTEMS MISCELLANEOUS PRODUCTS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for miscellaneous components and products for signal systems that the Contractor shall provide and install. All materials provided by the Contractor shall be new, unless designated on the railroad plans or approved by the Resident Engineer.

**1.02 REFERENCES**

- A. American National Standards Institute (ANSI)
  - 1. C80.1 Electrical Rigid Steel Conduit
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- C. Southern California Regional Rail Authority (Metrolink) Engineering Standards

**1.03 SUBMITTALS**

- A. Product Data: Submit manufacturer's catalog cuts, material descriptions, Specifications, and other data pertinent to the miscellaneous products required.
- B. Submit samples of solder-less crimp-on type terminals to be used in this Contract as well as samples of solder-less crimp-on type terminals from vendors performing house wiring.

**1.04 EXTRA MATERIALS**

- A. Furnish two gallons or equivalent volume of corrosion preventive compound. Compound shall be the same product as approved for use in the Work.

**PART 2 - PRODUCTS**

**2.01 GENERAL**

- A. All electrical components shall be rated to operate at power, voltage, current, and temperature levels exceeding by 20 percent those which the components will be subject to in service, unless otherwise specified herein.
- B. Miscellaneous components and products shall be clearly and permanently labeled with value or type identification.

**2.02 CIRCUIT BREAKERS AND FUSES**

- A. Circuit breakers and fuses shall be of suitable capacity to protect the various pieces of signal apparatus from the effects of short circuits or overloads. All circuit breakers and fuses required for the equipment and systems shall be in accordance with these Specifications.
- B. Circuit fuses shall be non-renewable, and shall be of the fiber-case, time lag, fusion type.
- C. The circuit breakers and fuses shall be the correct size and rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.
- D. All circuit breakers and fuses shall be centrally located on the power distribution panel and power racks.
- E. Fuse clips shall be constructed so that they shall retain their resilience under all installation and service conditions, to ensure a positive contact between the clips and the fuse.

**2.03 DIODES**

- A. Diodes to be furnished under this Contract shall carry a JEDEC number or shall be available from more than one manufacturer and shall be used within the published Specifications for such number. All diodes shall be silicon type, unless otherwise accepted by the Engineer.

**2.04 RESISTORS**

- A. Resistors, other than those required for electronic circuits, shall be in accordance with AREMA C&S Manual Part 14.2.15.

**2.05 REACTORS**

- A. Reactors, other than those required for electronic circuits, shall be in accordance with AREMA C&S Manual Part 14.2.20.

**2.06 SIGNAL TERMINAL BLOCKS**

- A. Signal system terminal blocks shall be in accordance with the applicable requirements of AREMA C&S Manual Part 14.1.5.

**2.07 TERMINAL BINDING POSTS**

- A. Signal system terminal binding posts shall be in accordance with the applicable requirements of AREMA C&S Manual Part 14.1.10.

- B. Terminal binding posts for interface with plug-coupled wires to rack mounted electronic equipment shall be in accordance with the AREMA C&S Manual, Part 14.1.2.

## **2.08 TERMINAL POST INSULATORS**

- A. All terminal posts, located on terminal boards in the wayside cases and signal instrument shelters, used to terminate 50V, or greater, ac or dc circuits, shall be provided with a protective insulator.
- B. The type of insulator shall be individual for each terminal post and shall be fire-resistant.

## **2.09 INSULATED TEST LINK**

- A. Type 024620-1X as manufactured by Siemens., or an approved equal.

## **2.10 LIGHTNING ARRESTERS AND EQUALIZERS**

- A. Siemens Clearview No. 022485-28X, Equalizer No. 022700-1X, or an approved equal. Lightning arresters and equalizers shall be mounted on accepted type base and shall be in accordance with AREMA C&S Manual Part 11.3.1.

## **2.11 SURGE PROTECTORS**

- A. Siemens SP-17, SP-18, SP-19, SP-20, or an approved equal. Surge Protectors shall be in accordance with AREMA C&S Manual Part 11.3.3.

## **2.12 TERMINALS FOR WIRES AND CABLES**

- A. Solderless terminals shall be in accordance with the AREMA C&S Manual, Part 14.1.1, unless otherwise specified herein.
- B. Terminals shall be of the solderless crimp-on type. Samples of all solderless terminals shall be submitted for approval.
- C. Stranded copper wire shall be fitted with an approved type of terminal at all points where the wires are to be terminated on terminal binding posts.
- D. The terminating means shall be of four types:
  - 1. A lug for terminating heavy wires or signal power wires.
  - 2. A solderless type of terminal as manufactured by American Pamcor, Inc., under the trade name of "Pre-Insulated Flags" with translucent insulation similar to Catalog No. 322313, or an approved equal, for terminating No. 16 and No. 14, American Wire Gauge (AWG) stranded wires.
  - 3. An AMP Solistrand "Ring Tongue-Flat" terminal, similar to that shown on the AMP Drawing P64044, together with slip-on nylon post insulator, similar to that shown on AMP Drawing P64-0264, or an approved equal, for

terminating wires larger than No. 14 AWG to a maximum diameter over the insulation of 0.40 inch.

4. An AMP pre-insulated; diamond grip ring nylon insulated wire terminal shall be used for terminating other stranded wires, No. 20 and No. 18 AWG, having maximum diameter of 0.125 inch. AMP Catalog No. 320554, or an approved equal, shall be furnished for No. 8 studs and AMP Catalog No. 320571, or an approved equal, shall be furnished for 1/4-inch studs.
- E. Terminals shall be for attaching to the ends of the conductor in such a manner that the flexibility of the conductor will not be destroyed and the possibility of breakage at the terminal will be reduced to a minimum.
- F. Terminals shall be for attaching to the wire with a tool made by the manufacturer of the terminal and recommended by the manufacturer for the terminals being furnished.
- G. The tool shall be equipped with a ratchet device to ensure proper indentation of the terminal, which will not release until proper indentation is complete.

### **2.13 TAGGING FOR CABLES, WIRES AND EQUIPMENT**

- A. Except as otherwise specified in this Section, permanently identify with a tag both ends of each cable, each cable wire, and all single wires that terminate in the junction boxes, switch mechanisms, signal instrument shelters, on equipment racks, relay bases, shelter, and any equipment of the signal system outside of such locations. Install tags so that they may be read with minimum disturbance of the tags. Each conductor of the cable shall be rung out and identified before applying the tag. Tagging shall follow the three-line convention with the termination in the first line, nomenclature in the second line, and termination of the other end of the wire in the third line. This three-line convention shall be in accordance with the Metrolink Engineering Standard 8150.
- B. Tags for wire and cable identification and for identification of transformers, resistors, reactors and other components shall meet the following requirements and shall be subject to Engineer's acceptance:
  1. Sleeve Type Tags:
    - a. Tags for identifying individual cable conductors and field-installed wires within the signal instrument shelters, wayside cases, switch mechanisms, switch layout junction boxes, base of signal junction boxes, and similar applications, shall be the sleeve type as manufactured by Raychem Corporation, Thermofit Marker System (TMS), or an approved equal. The application of the conductor nomenclature shall be in accordance with the manufacturer's instructions and shall result in a permanently bonded and legible identification.
  2. Flat Plastic Tags:



- a. Tags for identification of vital relay plug boards, individual transformers, resistors, reactors, terminals, and other miscellaneous components within the signal instrument shelters, wayside cases, and outside terminal cases, shall be the flat plastic laminated type.
- b. These tags shall be 1-1/2 inches long by 1/2-inch-wide. The untreated tag shall be milk white "vinylite", or an approved equal.
- c. The identifying nomenclature space shall allow for two rows of lettering, and the tag material shall be capable of receiving typed-on characters by conventional means. The height of the lettering shall not be less than 1/8 inch.
- d. After lettering, both the face and backside of the tag shall be covered with a clear plastic coating, "vinylite", or an approved equal.

## 2.14 HARDWARE

- A. Mounting hardware exposed to the elements and used for signal equipment, cases, conduit, hangers, brackets, clamps, and the like, shall be hot-dip galvanized in accordance with AREMA C&S Manual Part 15.3.1, except as otherwise accepted by the Engineer.
- B. Galvanizing:
  1. The hot-dip process of galvanizing shall be used. All parts shall be picked so that all scale and adhering impurities are removed. The zinc coating shall be of commercially pure zinc and shall be continuous and thorough. It shall not scale, blister, or be removable by any of the processes of handling or installation. The finished surface shall be free from fine line cracks, holes, or other indications of faulty galvanizing. It shall be smooth and free from adhering flux and other impurities. The edges and ends of parts shall be free from lumps and globules. Parts shall be coated with at least two ounces of zinc per square foot of galvanized surface, after all bending, cutting, drilling, and final fabrication.
- C. Cadmium Plating:
  1. Nuts, bolts, and washers shall be cadmium plated or stainless.
  2. Cadmium plating shall be an impervious, dense, hard, fine grained, continuous, closely adhering coating of commercially pure cadmium, free from capillaries and shall completely cover the surface of the part in a smooth, bright layer. Plating on raised or prominent portions shall show no evidence of blackness or loose crystalline structure. It shall have a minimum thickness of six ten thousandths of an inch and shall withstand the salt spray test for at least 1,000 hours or an equivalent test accepted by the Engineer.

## 2.15 CONDUIT

- A. Flexible Conduit
  - 1. Conduit for track circuit leads, switch-and-lock movements, and electric lock layouts shall be Liquid-Tite flexible conduit or an approved equal. The conduit shall be clamped at both ends with stainless steel clamps. Clamps are not required for track wire risers.
  - 2. Metallic Flexible Conduit: Where acceptable to the Engineer, metallic flexible conduit, Type UA, or an approved equal may be used.
- B. Fittings
  - 1. Approved fittings for flexible conduit shall be used.

## **2.16 PADLOCKS**

- A. Switch padlocks will be Owner-furnished.
- B. Signal padlocks will be Owner-furnished. The Contractor shall provide temporary padlocks until such time the equipment is placed in-service.
- C. Switch padlocks for the freight carrier's use will be SCRRA furnished. Provide all other padlocks to provide security of signal and electrical equipment until such time as the equipment is placed in-service and approved through final acceptance.
- D. Provide signal equipment padlocks until such time as the project is found to be acceptable and the Owner relieves the Contractor of maintenance responsibility. The Contractor and Owner or SCRRA will schedule a lock change out program directly related to the final acceptance of the project. The schedule shall be coordinated through the Resident Engineer. Present a list of equipment locks to be changed out by equipment and locations and the total number of locks that will be required to secure all the signal equipment.

## **2.17 SEALING COMPOUND**

- A. Sealing compound for use in sealing cable entrances shall be in accordance with AREMA C&S Manual Part 15.2.15.

## **2.18 CABLE ENTRANCE PIPES**

- A. Cable entrance pipes for wayside signal shelters shall be 4-inch PVC, Schedule 40, and 3 feet 6 inches long and extend 18 inches below the final grade.
- B. Cable entrance for wayside signals shall be 4 inch Liquid-Tite flexible conduit or an approved equal. Entrance pipe shall extend 18 inches below finished grade around signal.
- C. Cable entrance pipes are not required where a cable chute directly enters a pullbox.

## **2.19 JUNCTION BOXES**

- A. All junction boxes shall be provided with gaskets to prevent the entrance of moisture and dust, in accordance with AREMA C&S Manual Part 15.2.10.
- B. Junction boxes shall be provided to terminate underground cables at all switch and lock movements and all switch circuit controllers.
- C. Junction boxes shall be provided with means for applying padlock.

## **2.20 LUBRICATION**

- A. Lubrication for switch tie plates for all switch and lock movement layouts installed by the Contractor shall be an accepted graphite lubricant, similar to Dixon's Graphite "Railroad 60".

## **2.21 ENVIRONMENTAL PROTECTION (CORROSION PREVENTIVE COMPOUND)**

- A. Protection, as hereinafter specified for machine-finished surfaces, threaded rods, nuts, and other parts that are susceptible to rusting or corroding, shall be a corroding preventive compound, NO-OX-IDE No. 90918, or an approved equal. The product shall have sufficient body to resist weather and rusting for at least 6 months.

## **2.22 DC TRACK CIRCUITS**

- A. Transmitters shall be a 2TC or 3TC manufactured by Alstom, or an approved equal.

## **2.23 STYLE C TRACK CIRCUITS**

- A. Transmitter shall be a TD-4 as manufactured by Alstom, or an approved equal.

## **2.24 AUDIO FREQUENCY ISLAND TRACK CIRCUITS**

- A. Audio frequency island track circuits shall be AFTAC-II manufactured by Alstom, PSO manufactured by Siemens, or an approved equal.

## **2.25 OVERLAY TRACK CIRCUITS**

- A. Provide and install overlay track circuits EPIC III manufactured by Alstom, or an approved equal.

## **2.26 AC TRACK CIRCUITS**

- A. AC Track Circuits shall be steady energy such as the SE-3 manufactured by Siemens or an approved equal. Vane Relays shall not be used.

## **2.27 DATA RADIO**

- A. Data radio package shall be comprised of Siemens WCP II Radio, PN A53412; DC/DC Converter, PN A53106; and Wayside Control Unit, PN A53105.

**2.28 POWER OFF STROBE LIGHT**

- A. Power off strobe light and miscellaneous materials shall be packaged and shipped with each shelter to be installed as shown on the Contract Plans. Power off strobe light and miscellaneous materials shall be installed in the field by the installation contractor.
- B. Each shelter requiring a power off strobe light and Miscellaneous materials will include the following:
  - 1. 1 ea. Power Off Indication Light – S&C Distribution Company p/n 120-10, or an approved equal.
  - 2. 1 ea. Power Off Indication Light protective cage, metallic and powder coated to match exterior surface of instrument enclosure.

**2.29 ENCLOSURE ALARM SYSTEM**

- A. Intrusion alarm system to be supplied and installed inside of enclosure as depicted on the Contract Plans. Intrusion alarm system supplied by “ADEMCO No. V20 Pack”, or equivalent system approved by the Engineer.

**2.30 EXTRA MATERIALS**

- A. Furnish two gallons or equivalent volume of corrosion preventive compound, No-Ox-ID A-Special or approved equal. Compound shall be the same product as approved for use in the Work.

**PART 3 - EXECUTION****3.01 INSTALLATION**

- A. Material and apparatus specified herein shall be installed in accordance with the details of respective Sections of these Specifications, Metrolink Engineering Standards, manufacturer's recommendations, and in accordance with the Contract Drawings.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

- A. Furnishing, installing and testing Signal System Miscellaneous Products 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. Furnishing, installing and testing Signal System Miscellaneous Products 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 34 42 62**  
**SERVICE METERS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for 120/240, 100A three-wire, single-phase meter service and upgrading existing meter service to 120/240, 100A, 3-wire, single-phase meter service.
- B. Provide all interface with, and in conformance to the standards of the Local Power Company (LPC), to obtain the commercial metered power service at the locations shown on the Contract Plans and as required by the Engineer.
- C. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 34 42 56 – Signal Grounding

**1.02 REFERENCES**

- A. National Fire Protection Association (NFPA):
  - 1. 70 - National Electrical Code (NEC)

**1.03 SUBMITTALS**

- A. Submit Meter Service Plans, indicating mounting pole, meter base, breaker box, and grounding.
- B. Submit Peak load calculation for each meter location. Submit load calculation within 90 days of Notice to Proceed.
- C. Submit letter certifying that the installation of the meter service has been approved by the local electrical inspector.
- D. Submit a copy of each service order to the Resident Engineer for approval and to verify that each meter service planned falls within the Owners property.

**1.04 QUALITY ASSURANCE**

- A. Electrical service shall conform to the provisions in NFPA 70 National Electrical Code and these Specifications.
- B. Materials and equipment furnished and installed under this Section shall conform to all applicable State and local ordinances pertaining to electrical power installations, and the National Electrical Code (NEC).

**PART 2 – PRODUCTS****2.01 MATERIALS**

- A. Circuit Breakers
  - 1. Circuit breakers shall be sized by the Contractor for the projected loads. Circuit breakers for 120 Vac power shall be 2-pole rated for 240 Vac. Panels shall contain 25 percent spare circuit breaker space.
  - 2. One double pole circuit breaker shall be provided for future use, in addition to the 25 percent space circuit breaker space, specified herein.
- B. Meter Bases: Shall meet the requirements of LPC.
- C. Ground Rods and Ground Rod Clamps: Ground rods and ground rod clamps shall meet the requirements of Section 34 42 56, Signal Grounding, and those of the LPC.
- D. Wood Poles: Shall meet the requirements of LPC.
- E. Meter Pedestals and Bases: Shall provide and install meter pedestals and bases which meet the requirements of LPC.

**PART 3 - EXECUTION****3.01 GENERAL**

- A. Make the necessary arrangements with LPC and pay all fees in connection with having the new meter service hooked up at least one month prior to placing signal system in service.
- B. Arrange to obtain the service connection from LPC. Pay LPC charges for this service connection.
- C. Where the Contract Documents specify that the Owner will coordinate with the LPC, Contractor shall be responsible for installation and coordination with the LPC.

**3.02 COORDINATION**

- A. Coordinate the connection and interface of new cables and equipment with LPC in accordance with its standards.
- B. Shall be responsible for Local Power Company monthly charges from all new meters installed until SCRRA accepts full and final maintenance of the project. When final acceptance has been granted, the Contractor shall coordinate with SCRRA and the Local Power Company to transfer all new meter address to SCRRA at:

Southern California Regional Rail Authority  
ATTENTION: Pamela Hempsted  
900 Wilshire Blvd. Ste. 1500  
Los Angeles, California 90017

### **3.03 INSTALLATION**

- A. The installation of the various equipment and materials for the signal power distribution system that are specified herein shall be in accordance with LPC's requirements and the NEC.
- B. The requirements included within this Section shall cover all incidental installation work necessary to affect an integrated, tested, and operable signal power system for the Work as shown on the Contract Plans.
- C. Arrange utility power service at all equipment shelter locations requiring such services. Connections to equipment shelters from meter may be by underground or aerial connection. Where aerial connection is used, maximum aerial length between meter and shelter shall not exceed 125 feet without the Engineer's prior acceptance.
- D. The Contractor, in cooperation with the Engineer, shall meet as necessary with LPC representatives to negotiate for the upgrade, relocation, or addition of required power services needed to complete system operation.

### **3.04 GROUNDING**

- A. Meter service grounding shall be in accordance with Section 34 42 56, Signal Grounding, the NEC, and the LPC's requirements. If there is a conflict between the above specifications, LPC's requirements shall govern.

### **3.05 TESTING AND INSPECTION**

- A. Simulated load tests, in accordance with approved signal power system test procedure, shall be satisfactorily completed prior to final connection of signal facilities at each equipment location.
- B. Prior to final acceptance by the Engineer, obtain inspection of the new AC power service by state and local jurisdictional authority(s), as required.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Service Meters 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. Service Meters 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 34 42 64**  
**HIGHWAY-RAIL GRADE CROSSING WARNING SYSTEMS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes requirements for highway-rail crossing warning systems. These requirements shall also apply to pedestrian grade crossing warning systems, as applicable.
- B. As shown on the Contract Drawings, or as required to accommodate associated other work of the Contract, make modifications to the existing highway-rail crossing warning systems including such work as replacing, rewiring, or relocating of existing equipment or providing new control equipment and trackside equipment.
- C. Provide continuous operation of the highway-rail crossing warning systems in preparation for, and during, track installation and rehabilitation work.

**1.02 REFERENCES**

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).
- B. Code of Federal Regulations (CFR), Title 49, Transportation:
  - 1. Part 234 Grade Crossing Signal System Safety
  - 2. Part 236 Rules, Standards, and Instructions for Railroad Signal System
- C. General Orders (G.O.) of the State of California Public Utilities Commission (CPUC) shall apply:
  - 1. G.O. 75D: Protection of Crossing at Grade of Roads, Highways, and Streets with Railroads
- D. Southern California Regional Authority (Metrolink) Engineering Standards

**1.03 SYSTEM DESCRIPTION**

- A. Furnish and install new train detection equipment, wideband shunts, narrowband shunts, tuned joint couplers, dummy loads, shunt housings, insulated joints, and track connections for designated crossings.

- B. Provide continuous highway-rail crossing warning during all phases of rail construction. Refer to Section 01 14 00, Work Restrictions. At no time shall the work of the Contractor cause delay to train operation, cause an unsafe signaling condition to exist, or reduce the effectiveness or quality of the existing or new grade crossing warning systems.
- C. Provide rail bonding for new or modified rail joints or turnouts, as shown on the Contract Drawings. Provide rail bonding, as necessary, to maintain existing systems during construction.
- D. Protect existing signaling cabling and, where necessary, relocate existing cabling to prevent damage to the cabling during track installation, profiling, or grade crossing work.
- E. Record the final as-built conditions of the crossing warning system for each crossing.
- F. Perform and document all tests and inspections in accordance with CFR 49 regulations and these specifications.

#### **1.04 SUBMITTALS**

- A. Provide submittals for highway grade crossing devices, equipment, systems, assemblies, and detailed design in accordance with the requirements of Section 34 42 00, General Signaling Requirements.
  - 1. Submit, for approval by the Engineer, proposed plan for providing alternate methods of crossing warning during cutover and whenever the existing automatic crossing warning devices are deactivated, altered, or modified to accommodate construction work. Alternate methods shall conform to applicable parts of CFR, Title 49, including Part 234, and local ordinances.
  - 2. Alternative Foundation Design: If the Contractor proposes foundations different from those shown on the Contract Drawings, submit drawings of the type of foundations, including size and details of the galvanized anchor bolts, nuts, and washers, to the Engineer's approval. Include structural calculations with loadings and wind shear parameters. The Contractor's alternate final design drawings and calculations shall be approved and sealed by a professional engineer registered in California.
- B. Detailed Work Plan: The following work plan shall be coordinated with and integrated with submittals made under Section 01 14 00, Work Restrictions. Submit a detailed work plan, for approval and coordination by the Engineer, prior to making the changeover from the existing crossing warning system to the new crossing warning system. The Contractor's proposed plan shall detail the amount of time the warning system will be out-of-service and the substitute warning which will be provided to allow normal railroad operations to be

maintained. Change over of control, testing, and temporary-warning procedures shall be coordinated with the Engineer.

- C. Submit for approval of the Engineer a procedure plan for conducting quality assurance, component integrity, circuit continuity, circuit breakdown, and system operation tests.
- D. Submit product data for products furnished under this Section.
- E. Submit documentation of acceptance testing.
- F. Submit test reports within 3 days of testing.

### **1.05 DELIVERY, HANDLING, AND STORAGE**

- A. Package printed circuit cards separate from the constant warning time (CWT) units and all other electronic components with removable cards for shipment to the field. Protect each CWT unit and printed circuit card from damage or loss during handling and shipment.
- B. Protect precast concrete foundation units during handling to avoid damage in transit and at storage locations. Support, cushion, and stack to protect the edges of the units. Replace chipped, cracked, or damaged units.

## **PART 2 – PRODUCTS**

### **2.01 EQUIPMENT - GENERAL**

- A. Furnish materials and equipment for installation and for interconnection of the highway crossing warning as indicated on the Contract Drawings and specified herein. Materials and equipment shall be the products of manufacturers regularly engaged in the production of such material and equipment and shall be the manufacturer's latest design. Signaling materials and equipment shall be of a type and model that are in standard operation on major railway systems.
- B. Only those existing materials and equipment specifically identified on the Contract Drawings for re-use, relocation, or modification shall be incorporated in the highway-rail crossing warning systems. Materials and equipment shall conform to the provisions of AREMA Signal Manual, except as modified in this Section.
- C. Furnish trackside equipment, such as tuned joint couplers, narrow band shunts, and wideband shunts, as shown on the Contract Drawings. Furnish equipment shelters, predictors, track filters, chokes, and other equipment as shown on the Contract Drawings and as required for complete installation.
- D. Refer to Section 01 64 00, SCRRRA Furnished Material and Equipment, for lists of Owner-furnished equipment. Conduct and document acceptance testing of all components prior to transporting them from Owner-designated storage location.

**2.02 ELECTRICAL AND ELECTRONIC COMPONENTS - GENERAL**

- A. Design fusing and furnish fuses and printed circuit cards, connectors, and files in accordance with Section 34 42 00, General Signaling Requirements.

**2.03 CROSSING WARNING TRAIN DETECTION EQUIPMENT**

- A. Furnish and install constant warning time (CWT) type crossing train detection equipment, terminating shunts, surge panels, and arresters for the crossing configurations shown on the Contract Drawings.
- B. Furnish and install each CWT unit complete with the basic complement of printed circuit cards and additional circuit card(s) for functions such as upstream detection, downstream detection, preemption initiation, event recording, and all other materials necessary to complete the Work, as shown on the Contract Drawings.
- C. Make CWT unit audio frequency assignments following manufacturers' application guidelines with special attention being paid to frequency versus approach length and placement of adjacent channel narrow band termination shunts. Acceptable primary frequencies in Hz are 86, 114, 156, 211, 285, 348, 430, 525, 645, 790, and 970. Constant warning time systems shall include a high frequency, AFO track circuit for the island circuit. Acceptable island frequencies in kHz are 10.0, 11.5, 13.2, and 15.2 or the Alstom XP4 Random Signature Island frequency.
- D. Each highway-rail crossing unit shall consist of a primary grade crossing CWT controller and a redundant standby grade crossing CWT controller. Provide an automatic transfer unit to transfer the approach control function from the primary CWT controller to the standby CWT controller in event of the failure of the primary unit and back to the primary unit if the standby unit were to fail. House the automatic transfer unit in the same cabinet as the CWT normal and standby controller.
- E. Furnish and install constant warning time controller capable of detecting train movements on two separate track sections. Design CWT unit to allow selection of a different frequency for each track.
- F. Constant warning time crossing train detection equipment shall be Alstom XP4, Siemens GCP 4000, or GCP 5000 as shown on the Contract Drawings, or Approved Equal. Termination shunts shall be the CWT manufacturer's recommended type shunt for the frequency and application used. Furnish multi-frequency selectable termination shunts.
- G. Furnish and install termination shunts, adjustable inductors, filters, code isolation units, and the like, as recommended by the CWT controller equipment manufacturer, as shown on the Contract Drawings.

- H. Provide relays as shown on the Contract Drawings.
- I. The placement of the crossing approach shunts, as shown on the Contract Drawings, is determined by the maximum authorized train speed and a base crossing warning time of 30 seconds. Additional seconds have been added to account for equipment reaction time or other applicable considerations. Additional time, if required to accommodate the individual crossings' unique characteristics or as required for traffic signal preemption requirements, shall be as specified in the Contract Documents. Take necessary field measurements at the grade crossing and verify that the crossing warning time and shunt placement are valid for site conditions. Bring any discrepancies to the attention of the Engineer.
- J. Furnish and install an internal data recorder with the CWT unit capable of recording train speed, warning time, time and date, adjacent and auxiliary crossing detection times, and equipment errors. The recorder shall be capable of furnishing a report with only warning time, train speed, and time and date information and a separate report that includes error data.
- K. Furnish and install a separate solid state data recorder and crossing monitor capable of remote interrogation. The Micro-Aide CWR-72B Data Recorder as shown on the Contract Drawings or an approved equal, shall be used.
- L. Furnish and install a data recorder antenna and associated cables on each shelter as shown on the Contract Drawings.

#### **2.04 CROSSING WARNING GATES AND FLASHING LIGHTS**

- A. Furnish and install each highway-rail crossing warning device assembly complete with all associated hardware consisting of mast mounted gate mechanism, mast, junction box base, gate arm, flashing light unit(s), bell, signs, and miscellaneous hardware, as shown on the Contract Drawings, and as specified herein.
- B. The crossing gate warning device assembly shall conform to the requirements of CPUC GO No. 75D; CFR, Title 49, Part 234; and the relevant sub-parts of the AREMA C&S Manual Part 3.2.
- C. The gate mechanism housing shall be cast aluminum for mounting on a 5-inch diameter 16 feet aluminum pole and furnished complete with mounting brackets, counter-weight assembly, and counter-weights. Provide either single sided counter-weight brackets or double-sided counter-weight brackets as recommended by the manufacturer. Fit gate arm bracket with a breakaway arm adapter as shown in the AREMA C&S Manual, Part 3.2.21.
- D. The gate mechanism shall be of the power-up, power-down electro-mechanical type complete with internal relay and adjustable snubbing resistor.
- E. Furnish gate arms lengths required per the Metrolink Engineering Standards and

site conditions. Arms shall be of the aluminum with fiberglass extensions and fiberglass tip type. Gate arm lamps shall be LED conforming to the AREMA C&S Manual, Part 3.2.40. Provide high intensity lamps when shown on the Contract Drawings.

- F. Provide gate arm wind guards conforming to AREMA C&S Manual Part 3.2.22 with each gate assembly.
- G. Provide flashing light crossing signal units as shown on the Contract Drawings. Light units shall have 12-inch roundels with LED's and be complete with steel backgrounds, steel hoods, junction box, and cross-arm brackets.
- H. Provide a crossing warning bell conforming to the AREMA C&S Manual, Part 3.2.60 with each gate assembly, except that the bell shall be mounted on the cantilever structure when a cantilever is shown.
- I. Railroad crossing signs, multiple track signs, and the like, shall be extruded aluminum, reflex-reflective sheet type as recommended in the AREMA C&S Manual Parts, 3.2.70 and 3.2.75, respectively. Provide signs complete with all hardware for mounting on 5-inch mast or on a cantilever mast. All highway-rail crossings shall conform to CPUC signage requirements.
- J. Exit Gates will default to the vertical position when energy is removed. At a grade crossing, the entrance gates and the exit gates should be provided by the same manufacturer. The Western Cullen Hayes (WCH) Model 3593 E and the WCH Model 3597 EXIT gate mechanisms or approved equals are acceptable.
- K. Exit Gate Systems incorporating dynamic vehicular detection utilizing preformed inductive loops with a modular processor assembly shall provide a minimum of 8 inputs and 6 outputs per module. Operating parameters shall be accessible and programmable from the front of the module such as the Reno A & E Model E-1400 or approved equal. Modules shall be capable of synchronous loop frequency scanning.
- L. Exit Gate Systems incorporating dynamic vehicular detection utilizing radar systems shall use SmartSensor Matrix Rail sensors controlled by VDR24 controllers. Sensors shall be mounted on dedicated mounting masts as required by the manufacturer and as shown on the Contract Drawings. Radar based vehicle detection systems shall be Dual Radar Vehicle Detection Systems manufactured by Island Radar or approved equal.
- M. Control of Exit Gate operation shall be by a solid-state processing system which is user configurable with permission and password protection. The Exit Gate System shall be configurable to process gate position information for up to eight (8) individual gate mechanisms selectable to be either Entrance or Exit Gates. The Exit Gate System shall be configurable to process vehicular detection information for vehicle presence and detector loop health. User configuration and event analysis must be by a front panel LCD touch screen panel. Exit Gate controller shall have an event recording capability and the ability to serially

connect with another Exit gate controller of the same manufacturer. The Alstom ElectrologIXS, Alstom XP4, Siemens Solid State Crossing Controller IV (SSCCIV), or approved equal shall be used.

- N. Control of Entrance Gates shall be by a solid-state microprocessor system which contains a charging system and programmable gate delay. This controller may be a separate unit such as the Safetran SSCCIV or approved equal, or it may be an integrated modular component of the Constant Warning Time system such as the GCP4000, GCP 5000, Alstom XP4, or approved equal.

## 2.05 FOUNDATIONS

- A. Provide foundations for wayside equipment cases, highway-rail crossing gates, flashers, and cantilevers as specified herein.
- B. Precast or cast-in-place reinforced concrete foundations shall be monolithic or sectional construction and shall conform to the requirements for concrete work as specified in Section 03 31 00, Structural Concrete.
- C. Provide precast concrete foundations complete with anchor bolts, nuts, and washers in accordance with the AREMA C&S Manual, Part 14.4.
- D. All galvanized steel foundations to be furnished and installed shall conform with Section 34 42 60, Signal Systems Miscellaneous Products, and AREMA C&S Manual, Part 15.3.1.
- E. Galvanized steel foundations shall be constructed of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4-inch steel plate.
- F. Bolts, nuts, and washers shall be galvanized. Nuts and threads shall be in accordance with AREMA Specifications for Bolts, Nuts, and Threads, C&S Manual, Part 14.6.20. Plain washers shall be in accordance with AREMA Specifications for Plain and Spring Lock Washers, C&S Manual, Part 14.6.21. Steel shall be in accordance with AREMA Specifications for Various Types of Steel, C&S Manual, Part 15.1.4, Section 1. Bolts shall be of sufficient length to provide for leveling of the device.
- G. Place a conduit with a minimum 3-inch inside diameter in cast-in-place cantilever structure foundations for routing of cables to the cantilever junction box. The conduit shall protrude from the foundation sufficiently to enter cantilever structure ensuring cable is not exposed.

## 2.06 HARDWARE

- A. Furnish hardware in accordance with Section 34 42 60, Signal Systems Miscellaneous Products.



**2.07 CONDUIT**

- A. Conduit shall conform to the specifications in Section 34 42 18, Conduits and Pull Boxes.

**PART 3 - EXECUTION****3.01 GENERAL**

- A. Install and adjust equipment and materials in accordance with the appropriate requirements and recommendations of the equipment manufacturer, in conformance with the recommendations of the applicable parts of the AREMA C&S Manual; as required by CFR 49, Parts 234 and 236; applicable CPUC regulations; or as otherwise specified herein.
- B. Where existing grade crossing warning system shelters and gate assemblies are indicated to be relocated, remove, protect, transport, store, disassemble, re-configure where necessary, reassemble and reinstall as shown in the Contract Drawings and as required within the Metrolink Engineering Standards.

**3.02 INSULATED JOINTS**

- A. Install insulated joints as specified in Section 34 72 00, Trackwork (Appurtenances and Other Track Materials). Test each insulated joint in accordance with the requirements of the AREMA C&S Manual, Part 8.6.35, and per bonded joint and insulated joint section.

**3.03 RAIL BONDING**

- A. Install new, or maintain existing, and test rail bonding for electrical continuity as required for continuous train detection within the approach limits of the crossings.
- B. Double bond frog assemblies, switch points, and rail joints as specified in Section 34 42 54, Rail Bonding, with the type of bonds specified in Section 34 42 54, Rail Bonding.
- C. Make signal connection to rails using weld type track circuit connectors per Metrolink Engineering Standards.

**3.04 CROSSING WARNING SYSTEM**

- A. Install, connect, and test new equipment and cabling to the greatest extent practicable without disruption of the existing highway-rail crossing or signal systems.

**3.05 TRACK CIRCUITS**

- A. Install and adjust all track circuits in accordance with the requirements of AREMA C&S Manual, Parts 8.6.1, CFR 49, Parts 234 and 236, and as specified herein.
- B. Make all track circuit rail connections using weld type connectors.
- C. Adjust each track circuit for a detection sensitivity of 0.06 ohm throughout the length of the track circuit, including within the shunt fouling limits of turnouts.
- D. Record voltage and current measurements at both feed and receive ends of each track circuit in a format approved by the Engineer.

### **3.06 HIGHWAY-RAIL CROSSING EQUIPMENT**

- A. Install grade crossing warning equipment in conformance with CFR, Title 49 Part 234; CPUC G.O. 75D; approved submittals; and as shown on the Contract Drawings.
- B. The final voltage adjustment and alignment of the flashing light units and final balancing of the gate arms shall be made at the time of the functional test. Final adjustments and alignments shall be made in conformance with the requirements of the AREMA C&S Manual, Parts 3.3.1 and 3.3.5 and CFR 49 Part 234.
- C. Provide new cabling between the wayside gate/flasher and the crossing control shelter except where the Contract Drawings specifically specify the re-use of the existing cabling.
- D. Furnish and install pedestrian gates in accordance with the Contract Drawings and installation instructions furnished by the Engineer.

### **3.07 FOUNDATIONS**

- A. Excavate, backfill, compact, and clean-up excavation as specified in Division 31-Earthwork.
- B. Install each foundation in accordance with the approved installation detail for each type of foundation and as specified herein. The absence of a specific task listing herein does not relieve the Contractor of the responsibility for providing a complete and functional installation. The installation tasks that must be completed by the Contractor are included herein.
- C. Prior to placing precast foundation or constructing cast-in-place foundations, excavate completely to the lines and grades required and install crushed stone base in accordance with the requirements specified.
- D. Install foundations to the lines, grades, and dimensions required as determined by the Contractor and approved by the Engineer. Install mounting bolts of

sufficient length to accommodate use of leveling nuts between the base of the mechanism and the top of the foundation.

- E. When placing foundations, ensure that anchor bolts have not been bent and that the threads are undamaged. Protect anchor bolt thread, washers, and nuts by applying friction tape, or other method approved by the Engineer, until such time as the wayside equipment is installed. Bring damaged anchor bolts to the immediate attention of the Engineer. Do not use damaged anchor bolts. Remove and replace damaged anchor bolts and completely or partially remove and replace foundation as determined by the Engineer.
- F. Exposed poured concrete foundations shall be rubbed to obtain a uniformly smooth, clean surface of even texture and appearance.
- G. Provide nonconductive material between the foundations and the mounted apparatus to prevent direct contact between the concrete and metal surfaces.

### **3.08 CONDUIT**

- A. Install conduit as shown on the Contract Drawings and as specified herein.
- B. After conductors have been installed, seal ends of conduits terminating in instrument shelters, junction boxes, and equipment cases with an approved type of sealing compound.
- C. Bore or jack conduit under the existing trackbed at any traverse, except that conduit may be placed under the track prior to the track renewal.
- D. Place conduit to a minimum depth of 36 inches below finished grade except where specifically noted otherwise.

### **3.09 REMOVING, REINSTALLING AND SALVAGING EQUIPMENT**

- A. Relocate, reuse, modify, and salvage existing equipment as shown on the Contract Drawings. Refer to Section 31 11 50, Demolition, Cutting and Patching, for salvage requirements. Inventory existing relays and controlling equipment prior to delivering to the Engineer's designated storage location.
  - 1. Newly re-wire any existing equipment designated to be reused except as noted on the Contract Drawings.
- B. Removed equipment and materials not designated for reuse or salvage shall become the property of the Contractor and disposed of. Refer to Section 31 11 00, Site Clearing, for disposal requirements.
- C. Change existing crossing warning systems over to the new systems as expeditiously as practicable. Remove retired equipment immediately and keep work site kept free of debris and packaging materials.

### 3.10 FIELD QUALITY CONTROL

- A. Perform testing in accordance with Section 34 42 58, Signal Systems Testing, including documentation requirements.
- B. Prepare test procedures and perform and document tests on the highway-rail crossing components and systems as follows:
  - 1. Include all tests herein specified, as specified in the appropriate sections of the AREMA C&S Manual, and the FRA Rules, Standards, Instructions for Railroad Signal Systems, CFR 49 Part 234 and 236.
  - 2. Perform pretests on all procedures in advance of actual testing.
  - 3. Perform applicable tests to each interim signal system, if any, before placing in service.
  - 4. Actual testing shall be witnessed by the Engineer.
- C. Make measurements at each piece of wayside equipment and record on the as-built record drawings verifying that the equipment is located where shown on the Contract Drawings and as approved by the Engineer. Verify, by measurement, that the equipment does not violate the train dynamic clearance envelope.
- D. Test each grade crossing warning installation in accordance with Section 34 42 58, Signal Systems Testing, and the AREMA C&S Manual, Parts 3.3.1 and 3.3.5. In addition, perform all applicable tests as described in the SCRRA Instructions Governing Installation, Maintenance, Inspection and Testing of Signal Apparatus and Signal Systems, all manufacturer's recommended test and adjustment procedures, and any tests required by regulation.
- E. Disconnect and ground associated signal equipment not under test. Disconnect or unplug electronic devices or signal equipment prior to any testing.
- F. Follow manufacturer's instructions for testing of operation and electronic equipment.
- G. Submit test data and results to the Engineer's information and approval within 24 hours of placing the apparatus or system in operation.

## PART 4 – MEASUREMENT AND PAYMENT

### 4.01 MEASUREMENT

- A. Pedestrian or Vehicular gates and Flashing Light Assemblies will be measured by the unit or fraction thereof furnished, assembled, 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. Microprocessor based crossing equipment shall be measured by the unit or fraction thereof furnished, assembled, 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. Preformed inductive loops and radar equipment shall be measured by the unit or fraction thereof furnished, assembled, 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. Narrow Band Shunts, Wideband Shunts and Tuned Joint Couplers (NBS, WBS & TJC's) 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 or Vehicular gates and Flashing Light Assemblies 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. Microprocessor based crossing equipment 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 programming, 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. Preformed inductive loops and radar equipment shall be assemblies 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 programming, 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. Narrow Band Shunts, Wideband Shunts and Tuned Joint Couplers (NBS, WBS & TJC's) 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.
- E. The Narrow Band Shunts, Wideband Shunts and Tuned Joint Couplers (NBS, WBS & TJC's) shall include the cost of related enclosures, track wires and exothermic track connections and all associated equipment, conduits, mounting hardware, trenching and filling, adjustments and testing as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
- F. 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 34 42 66**  
**DRAGGING EQUIPMENT DETECTOR SYSTEMS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. The work in this Section shall include providing detailed design, furnishing and installing a complete Dragging Equipment Detector as specified herein and as shown on the Contract Drawings.

**1.02 QUALITY ASSURANCE**

- A. Dragging equipment detector and automatic equipment identification reader shall be tested in accordance with the manufacturer's requirements.

**1.03 SUBMITTALS**

- A. Submit shop drawings for Dragging Equipment Detector System to the Engineer for approval. Shop drawings, at a minimum, shall show location and method of installation for the instrument enclosure and track mounted detector appurtenances.
- B. Field Engineering Survey of the proposed installation site validating conformance to manufacturer's installation requirements, or detailing improvements required to the track structure, which will be performed by others.
- C. Manufacturer's Installation, Maintenance and Training manuals for each of the various systems composing the complete installation.
- D. Manufacturer's software for each of the detector and monitoring systems.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Signal bungalow and any equipment therein shall be shipped, stored and handled as specified in Section 34 42 46, Signal Equipment Houses.

**PART 2 – PRODUCTS**

**2.01 MATERIALS**

- A. Double-track Dragging Equipment Detector system.
- B. Bungalow to house detector monitoring devices.
- C. Radio talker equipment.
- D. Standby Battery sized sufficiently for the detector systems.

## 2.02 MATERIAL DETAILS

- A. The Dragging Equipment Detector system shall utilize mechanical paddle detectors like the Alstom Self Restoring Paddle that can be interconnected and output a female voice or an approved equivalent system.
- B. Defect Detectors shall conform to all applicable parts in Section 5 “Defect Detector Systems” of the AREMA C&S Manual.
- C. The Automatic Equipment Identification system shall consist of an antenna, a reader and a processor utilizing a radio frequency transceiver reading system capable of scanning standard AAR AT5110 equipment tags.
- D. The defect detection system shall be an integrated system composed of all subsystems and capable of future integration of typical railroad defect detection systems such as hot bearing and hot wheel detectors.
- E. All battery, communication, and detector monitoring equipment shall be housed in a standard Metrolink bungalow as described in Section 34 42 46, Signal Equipment Houses and shown on the Contract Drawings. Placement of equipment in bungalow shall allow for the future installation of equipment for a double-track hot bearing and hot wheel detector system.
- F. A 5-watt radio system with a roof-mounted antenna shall be configurable to broadcast the status of all trains, or to only broadcast alarms from the various defect detection systems on the voice channel and to report health status to Metrolink via a separate data path. The digitized radio voice shall announce “Metrolink detector, milepost ###.#” on AAR channel ###/### when broadcasting.
- G. The standby power and charging system shall be sized to provide 48 hours of continuous operation in the event of an AC power failure and conform to the requirements of Section 34 42 52, Rectifiers, Batteries and Battery Charging Equipment.
- H. The defect detection system shall be capable of communicating via a radio-based Ethernet data communication link.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Design, Furnish and Install a complete Defect Detector System consisting of a Dragging Equipment Detector system, including all transducers, audio frequency overlay track circuits and all other trackside equipment.

### 3.02 TESTS



- A. Perform all tests to Manufacturer's Standards and as specified in Section 34 42 58, Signal System Testing, ensuring system operation.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Dragging Equipment Detector 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. Batteries and Chargers will not be measured and shall be considered incidental to the installation of the Dragging Equipment Detector Systems.
- C. Grading and site preparation required for the installation of Dragging Equipment Detector will not be measured and shall be considered incidental to the installation of the Dragging Equipment Detector Systems.

### **4.02 PAYMENT**

- A. Dragging Equipment Detector 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.
- C. No separate payment shall be made for any grading or site preparation required for the installation of Dragging Equipment Detector and shall be considered incidental to the installation of the Dragging Equipment Detector Systems.

**END OF SECTION**

**SECTION 34 42 70**  
**WAYSIDE SIGNAL ASSEMBLIES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. The Section includes the requirements for furnishing and installing wayside signal assemblies.
- B. Wayside signal assemblies shall consist of ground-mounted masts, color-light signal heads with LED lamps, backgrounds, visors, number plates (for automatic signals), ladders, platforms, foundations, and all mounting hardware required to construct absolute (interlocking) and automatic signals.
- C. Contractor shall furnish and install signals as specified herein and as shown on the Contract Drawings.
- D. Related Specification Sections include but are not necessarily limited to:
  - 1. Section 03 31 00 – Structural Concrete
  - 2. Section 31 20 00 – Earthwork
  - 3. Section 34 42 58 – Signal System Testing
  - 4. Section 34 42 60 – Signal Systems Miscellaneous Products

**1.02 REFERENCES**

- A. American Association of State Highway and Transportation Officials (AASHTO):
  - 1. LTS-4 Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals
- B. American Railway Engineering and Maintenance of Way Association (AREMA)
  - 1. Communications and Signals Manual of Recommended Practices (C&S Manual)
- C. Southern California Regional Rail Authority (Metrolink) Engineering Standards
- D. Code of Federal Regulations, Title 29, Occupational Safety and Health Administration (OSHA)
  - 1. Part 1910 Subpart D “Walking-Working Surfaces”

**1.03 QUALITY ASSURANCE**

- A. Wayside signal assemblies shall meet the requirements of AREMA C&S Manual part 7 and applicable portions of Manual Part 3.2.5, where requirements of the AREMA Specifications do not conflict with requirements specified herein.
- B. Inspect each signal assembly after it has been installed in the field. This inspection shall conform to the Contractor's Installation Procedure as accepted by the Engineer.
- C. L.E.D. Lamp Units shall meet the requirements of AREMA C&S Manual Part 7.1.5.
- D. Signal aspect shall be distinct and unmistakable when viewed from a height of 7 to 12 feet above top of rail at a distance of 1,000 feet. Nominal sighting distance shall be 2000 feet. Where unobstructed sighting distance for a standard signal arrangement is less than 2000 feet, provide to the Resident Engineer written notifications of sighting problems and locations.
- E. Foundations shall meet all requirements of AREMA Signal Manual Part 14.1.1 through 14.4.41 inclusive, where requirements of the AREMA Specifications do not conflict with requirements specified herein.
- F. Resident Engineer reserves the right to make inspections and tests, as necessary, to determine if the equipment meets the requirements of these Specifications.

#### **1.04 SUBMITTALS**

- A. Contractor shall submit shop drawings for each type of signal unit and each type of signal layout to the Resident Engineer for approval. Show all ladders, masts, bases, arms and required mounting hardware. Show location and method of mounting the signals to the structure.
  - 1. Provide necessary dimensions, hardware, method of mounting signals, and material specifications for all items to be furnished.
- B. Submit shop drawings for structure foundations.
- C. Submit Installation procedure for approval by the Resident Engineer. The procedure shall include a detailed description of installation activity and sufficient detail to allow the Resident Engineer to determine the validity of the installation procedure.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Ship lamp units separately from the signal head in which they will be used.
- B. Contractor shall ensure that all wayside signal assemblies and signal lamp units are safely stored and protected from damage during storage, handling and transporting.

#### **1.06 WARRANTY**

- A. Contractor shall provide warranty from defects arising from defective parts, workmanship, and lightning damage for 2 years from the first date of service.

**PART 2 – PRODUCTS****2.01 MATERIALS**

- A. Contractor shall furnish color-light signal heads as specified herein, and as shown on Metrolink Engineering Standard 8525
- B. Contractor shall furnish ground signal assemblies in accordance with these Specifications, and Metrolink Engineering Standard 8500 and 8505, as appropriate for site-specific requirements.

**2.02 SIGNAL HEADS**

- A. Signal head shall be furnished with L.E.D. lamp units, blank out cover plates (if applicable), hoods, background, mounting brackets, and U-bolts to fit 5-inch mast assemblies that Contractor proposes to furnish.
- B. Signal head shall include mounting bracket for 5-inch mast and stainless steel fasteners.
- C. Color-light signal units shall be capable of displaying three aspects: green, yellow and red as shown on Metrolink Engineering Standard 8525
- D. Install blank-out cover plates in all unused lamp units.
- E. Signal head shall be designed to allow removal of lamp units from the rear.
- F. Dwarf signals shall be in accordance with Metrolink Engineering Standard 8520.
- G. Signal access covers (doors) shall be provided with a means of securing in closed position.

**2.03 GROUND SIGNAL ASSEMBLIES**

- A. Contractor shall furnish ground signal assemblies in accordance with Metrolink Engineering Standard 8500, as appropriate for site-specific requirements.
- B. Ground signal assemblies shall consist of an aluminum five-inch mast structure, junction box, liquid-tight flex conduit, platform(s), ladder, ladder foundation, grounding pigtail welded to the mast structure, and shall be equipped with all mounting hardware to accommodate the required arrangement of signal heads.
- C. Each ground signal assembly must be fully compliant with the latest OSHA and CAL-OSHA fall protection requirements in effect at the advertisement of this Contract. Where a conflict exists between the requirements, the most stringent shall apply.

**2.04 SIGNAL MASTS**

- A. Signal masts shall be predrilled for the placement of signal unit(s) by the

manufacturer at the factory. Nominal signal mast height is between 21'-0" and 21'7". A 5-inch cap for top of mast shall also be provided with each mast unit.

- B. The base section shall be designed to accommodate a 5-inch mast. The dimensions of the foundation bolt hold centers in the base shall be as specified on Metrolink Engineering Standards 8500 and 8505.
- C. Signal mast shall be fitted with one (1) 48-inch long No. 2 ground wire cad-welded to the mast as shown on Metrolink Engineering Standards 8500 and 8505. The pigtail shall be coiled and secured in a manner that prevents during construction and while in transit.
- D. Grounding for signal mast shall be as specified in Section 34 42 56, Signal Grounding.

## **2.05 LADDERS AND PLATFORMS**

- A. Platforms and ladder mounting brackets shall be constructed of galvanized steel and shall be in accordance with AREMA Signal Manual Part 7.2 and Metrolink Engineering Standards 8500 and 8505.
- B. Ladders shall be constructed of aluminum having non-slip rungs and capable of supporting the weight of two people. Two hinged flat plates shall be fitted to the ladder to prevent unauthorized access to both sides of the ladder. The covers shall be locked in place by a signal padlock and hasp arrangement intended for this purpose.
- C. Ladder platform cages shall extend a minimum of 42 inches above the top of landing.

## **2.06 JUNCTION BOXES**

- A. Junction box shall be in accordance with Metrolink Engineering Standard 8530.
- B. Junction box shall be mounted as shown in Metrolink Engineering Standards 8500 and 8505. Junction box shall be securely fastened to the mast using 5-inch U-bolts. Junction box shall be furnished with a minimum of 28 AAR test (multi-unit) terminals in accordance Metrolink Engineering Standard 8330, and a 4-inch liquid tight flex conduit 8ft. length with liquid-tight flex conduit 8ft. in length with liquid-tight fitting.

## **2.07 FOUNDATIONS**

- A. Furnish foundations for ground signals in accordance with Metrolink Engineering Standard 8255.
- B. Furnish galvanized steel foundations complete with galvanized bolts, washers, nuts and associated hardware. Galvanizing shall conform to Specifications Section 34 42 60, Signal Systems Miscellaneous Products, and AREMA Signal Manual, Part 15.3.1.

- C. Construct galvanized steel foundations of steel angle and plate welded together. Foundations shall be constructed of 2 1/2 inch by 2 1/2 inch by 1/4 inch steel angle and 1/4 inch steel plate.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION - SIGNALS**

- A. Contractor shall furnish and install signal layouts in locations as indicated on the Contract Drawings and as shown on the accepted shop drawings. No part of any signal layout shall conflict with Metrolink Engineering Standards, Code of Federal Regulations, Part 49, nor installed within the clearance envelope as defined in CPUC G.O. 26-D.
- B. Locate signals centered between insulated joint, except where physically not possible. In such instances, submit a recommendation to the Resident Engineer for approval.
- C. Center line of signal mast shall be 15 feet 0 inches from centerline of track unless a deviation from this is approved by the Resident Engineer, as shown on the Contract Drawings or required to meet CPUC clearance requirements.
- D. Install signal unit level and plumb on their foundations. Leveling nuts shall be used as shown on Metrolink Engineering Standards.
- E. Install signal layouts in accordance with the applicable requirements of AREMA Signal Manual, Part 7.4.1 and Metrolink Engineering Standards.
- F. Install platforms for each signal unit level.
- G. Align signals for maximum viewing distance before placing in service.
- H. Refer to Design Requirements herein regarding signal aspect and sighting distances. Install signals and verify sighting distances. Provide the Resident Engineer with written notification with any sighting problems.
- I. Mount signal heads on an offset arm as shown in the Metrolink Engineering Standards. Signal heads shall also be able to swivel on the offset arm and be adjustable.
- J. Signal nomenclature shall be as shown on the Contract Drawings.
- K. The underground cable shall be dressed, pot-headed, tagged and terminated in the signal junction box as specified in Section 34 42 60, Signal Systems Miscellaneous Products. The number of conductors and conductor size of the underground cables shall be as shown in the contract drawings.
- L. Wiring from the junction box base to the signal heads shall be No. 10 AWG copper stranded wire as shown on the Contract Drawings.

- M. Install identification tags on each wire. These tags shall bear the nomenclature shown on the accepted Shop Drawings.
- N. Set lamp voltage between 8.8 volts and 9.2 volts measured at the signal lamp.

### **3.02 INSTALLATION – JUNCTION BOXES AND CABLING**

- A. The junction box shall have two terminals with insulated test links for each cable conductor, as specified in Section 34 42 60, Signal Systems Miscellaneous Products.
- B. Junction box placement and cable entry to the junction box shall be as shown on Metrolink Engineering Standards 8500 and 8505.
- C. The method of routing #10 flex wire from the junction box to each signal mounted on the structure shall be to route the wire within the tubular members of the structure. Pull wires entirely through the structure members, mast and signal mounting brackets, unless otherwise approved by the Resident Engineer.
- D. Provide pull boxes located a maximum of 5 feet from each signal. Edges shall be smooth and rounded to accommodate cable installation.

### **3.03 INSTALLATION - FOUNDATIONS**

- A. Install each foundation in accordance with the approved Contractor's Installation Procedure for each type of foundation, as herein specified, and as shown on the Metrolink Engineering Standards. The absence of a specific task listing herein does not relieve the Contractor of the responsibility for providing a complete and functional installation.
- B. Refer to Section 01 14 49, Coordination with Utilities, for requirements for locating and protecting existing utilities. Advise the Resident Engineer immediately if any utility or cable interferes with foundation work. After locating interference, allow 72 hours for the Resident Engineer to relocate or mitigate the interference.
- C. Prior to placing steel foundations in the excavations, place and compact a crushed stone base in accordance with Section 31 20 00, Earthwork.
- D. When placing foundations, exercise care and ensure that anchor bolts are not bent, or threads damaged. Protect anchor bolt threads, washers, and nuts by applying friction tape or other accepted method satisfactory to the Resident Engineer, until the unit to be supported is installed.
- E. After back filling excavation, the Contractor shall ensure that the foundation is plumb and level. Where ground signal foundations are installed, the top of the foundation shall be no higher than the nearest rail and no lower than the top of nearest tie. Under no circumstance shall the top of the foundation be more than 24 inches above final grade.

- F. Foundations shall be installed to the lines, grades and dimensions required as determined by the Contractor and accepted by the Resident Engineer. Mounting bolts shall be of sufficient length to accommodate use of leveling nuts between the base of the equipment to be supported and the top of the foundation.
- G. The Contractor shall provide a means to prevent entry of rodents and insects at the bases of the vertical masts.

### **3.04 PAINTING**

- A. Touch up any damaged painted finish.

### **3.05 FIELD TESTS**

- A. Make tests for proper operation and setting of lamp operating voltages in accordance with Section 34 42 58, Signal Systems Testing.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Wayside Signal Assemblies 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. Wayside Signal Assemblies 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 34 42 75

### POSITIVE TRAIN CONTROL WAYSIDE EQUIPMENT

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. This Section includes requirements for furnishing, installing, testing, and documenting Positive Train Control (PTC) Wayside Equipment.
- B. Related Specification Sections include but are not limited to:
  - 1. Section 34 42 58 - Signal Systems Testing.
  - 2. Section 34 44 98 – Positive Train Control Initialization Equipment.
  - 3. Section 34 44 99 – Positive Train Control Base Station Equipment

##### 1.02 REFERENCES

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
  - 1. Part 236: Rules, Standards, and Instructions for Railroad Signal System.
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communication and Signals Manual of Recommended Practices (C&S Manual).
- C. Association of American Railroads (AAR):
  - 1. Manual of Standards and Recommended Practices, Section K–I, Railway Electronics Systems Architecture and Concepts of Operations.
  - 2. Manual of Standards and Recommended Practices, Section K–III, Wayside Electronics and Mobile Communications Architecture.
  - 3. Manual of Standards and Recommended Practices, Section K–IV, Office Architecture and Railroad Electronics Messaging.
  - 4. Manual of Standards and Recommended Practices, Section K–VI, Railway Data Management and Communications.
- D. Southern California Regional Rail Authority (SCRRA):
  - 1. PTC Configuration Management (CM) Plan

**1.03 SUBMITTALS**

- A. Product Data: Manufacturer's catalog cuts, material descriptions, and specifications for each type of PTC Wayside Equipment the Contractor proposes to provide and install.

**1.04 QUALITY ASSURANCE**

- A. Perform operational testing of the equipment in accordance with the requirements specified in Section 34 42 58 - Signal Systems Testing.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Ship the PTC Wayside Equipment separately. Package modules individually in ESD safe packaging, in a sturdy carton with the type of module printed on the outside of the carton.

**1.06 WARRANTY**

- A. Provide warranty from defects arising from improper handling for 2 years from the first date of service.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- A. Wayside Messaging Server
  - 1. The Wayside Messaging Server (WMS) shall be a TransAir WMS-2000 manufactured by Lilee Systems or approved equivalent.
  - 2. The WMS shall support an operating voltage of 12VDC.
  - 3. The WMS shall have an internal module capable of cellular communication.
- B. PTC Radio
  - 1. The PTC Radio shall be an ITC 220 Wayside Radio (Part Number 133980) manufactured by CalAmp or approved equivalent.
  - 2. The PTC Radio shall be capable of operating between 217.6 and 222.0 MHz.
  - 3. The PTC Radio shall support an operating voltage of 12VDC.
- C. Surge Protection

1. PTC related surge protection shall be the 12R ICP (Part Number 1101-624) manufactured by Transtector Systems or approved equivalent.
  2. Surge protection unit shall be capable of mounting on a 35 mm DIN Rail and support a maximum continuous operating voltage of 14VDC.
- D. GPS/Cell Antenna
1. The GPS/Cell Antenna shall be the Mobile Mark GPS Antenna (Part Number V5501-A) distributed by ARMS, Inc. or approved equivalent.
  2. The GPS/Cell Antenna shall be composed of one GPS and two Cellular Antennas.
  3. The GPS/Cell Antenna shall mount to the signal shelter with the Antenna Mount Kit (1.25" Pipe GPS with Bracket) manufactured by PTMW, Inc. or approved equivalent.
- E. PTC Antenna
1. The PTC Antenna shall be the Yagi Directional Antenna (Part Number SY206-SF11SNM-U) manufactured by Sinclair or approved equivalent.
  2. The PTC Antenna shall have a frequency range between 217 and 225 MHz and a nominal gain of 9.5 dBd.
- F. PTC Antenna Tower
1. The PTC Antenna Tower shall be the 60 foot Tilt-Down Tower (Part Number SQT60MXHD) manufactured by Western Towers or approved equivalent.
- G. Polyphasers
1. The GPS Polyphaser shall be the DGXZ+06NFNF-B 800 to 2500 MHz Surge manufactured by PolyPhaser or approved equivalent.
  2. The PTC Polyphaser shall be the 50-700 MHz Arrestor (Part Number IS-B50HN-C1) manufactured by PolyPhaser or approved equivalent.
  3. The Cell Polyphaser shall be the .700 – 2.7 GHz DSXL Arrestor (Part Number DSXL) manufactured by PolyPhaser or approved equivalent.
- H. Category 5 Cable
1. Category 5 Cable shall be the Category 5E Patch Cord manufactured by HellermannTyton or approved equivalent.
  2. Category 5 Cable shall be composed of four pair cable and assembled with a snag less latch and strain relief boot.

3. Category 5 Cable shall be factory made. Contractor shall determine appropriate cable lengths for each connection and submit to the Resident Engineer for review.
- I. Coax Cable and Connectors
    1. Cellular
      - a. Cellular coax cable shall be the 5/8" Flexible Low Loss Communications Coax (Part Number LMR-240-MA) manufactured by Times Microwave Systems or approved equivalent.
      - b. Cellular coax cable connectors shall be the 5/8" N Mate Straight Plug type (Part Number EZ-240-NMH-D) and the Type TNC Male Plug (Part Number TC-240-TM) manufactured by Times Microwave Systems or approved equivalent.
      - c. Cellular coax cables and connectors shall be factory made. Contractor shall determine appropriate cable lengths for each connection and submit to the Resident Engineer for review.
    2. PTC
      - a. PTC coax cable shall be the 1/2" Superflex Corrugated coax cable (Part Number FSJ4-50B) and the 7/8" HELIAX Corrugated coax cable (Part Number AVA5-50) manufactured by Andrew or approved equivalent.
      - b. PTC coax cable connectors shall be the 1/2" Coax NM Connector (Part Number F4PNMV2-HC), the 7/8" HELIAX Positive Stop Coax N male Connector (Part Number AL5NM-PSA) and the 7/8" HELIAX Positive Stop Coax N female Connector (Part Number AL5NF-PSA) manufactured by Andrew or approved equivalent.
      - c. PTC coax cables and connectors shall be factory made. Contractor shall determine appropriate cable lengths for each connection and submit to the Resident Engineer for review.
    3. GPS
      - a. GPS coax cable shall be the 1/2" HELIAX Superflex Corrugated coax cable (Part Number FSJ4-50B) manufactured by Andrew or approved equivalent.
      - b. GPS coax cable connector shall be the 1/2" Coax N male Connector (Part Number F4PNMV2-HC) manufactured by Andrew or approved equivalent.
      - c. GPS coax cables and connectors shall be factory made. Contractor shall determine appropriate cable lengths for each connection and submit to the Resident Engineer for review.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Install PTC Wayside Equipment at locations indicated on the Contract Plans.
- B. Install equipment in accordance with the manufacturer's installation and adjustment procedures.
- C. All outdoor connectors, splices, antennas and ground kits shall be weather sealed.

### **3.02 TESTING**

- A. Conduct all tests required under Section 34 42 58 - Signal Systems Testing.
- B. All PTC Wayside Radios shall be tested by the Contractor for function and performance.
  - 1. Functional tests shall include:
    - a. DC supply voltage measurement
    - b. Forward and reflected transmit power. Voltage Standing Wave Ratio (VSWR) shall be calculated from the forward and reflected power measurements.
    - c. Frequency accuracy measurement
  - 2. Performance tests shall determine whether messages are delivered to their correct destination, (both base and locomotive), measuring reliability, throughput, and latency. A Bit Error Rate (BER) test for a minimum duration of 24 hours shall be performed to measure reliability.
  - 3. Tests shall include interoperable tests for track areas where more than one railroad operate. This shall include database verification and operations testing for each railroad.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Positive Train Control Wayside Equipment 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. Positive Train Control Wayside Equipment 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 34 44 00**

### **RAILROAD COMMUNICATIONS REQUIREMENTS**

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

##### **1.01 SUMMARY**

- A. The work in this Section includes, but is not limited to, general procedures and requirements and incidental to the review, planning, manufacturing, assembly, installation, removal, relocation, modification, testing, commissioning, and documentation of as-built conditions of the various Railroad Communication Systems.
- B. Provisions of this Section apply to all Sections of Division 34, Transportation, Subdivision 34 44, Railroad Wayside Communications.
- C. Additional technical requirements specific to communications subsystems are found in the corresponding subsystem Specification Sections.

##### **1.02 RELATED SECTIONS**

- 1. Section 01 14 19 – Coordination with Utilities
- 2. Section 01 25 00 – Substitution Procedures
- 3. Section 01 29 73 – Schedule of Values
- 4. Section 01 33 00 – Submittal Procedures
- 5. Section 01 25 23 – Site Safety Requirements
- 6. Section 01 35 15 – Maintenance and Protection of Railroad Traffic
- 7. Section 01 43 23 – Contractor Qualifications and Requirements
- 8. Section 01 56 37 – Worksite Security Requirements
- 9. Section 01 78 39 – Project Record Documents
- 10. Section 31 20 00 – Earthwork
- 11. Section 31 23 50 - Excavation Support Systems

##### **1.03 REFERENCES**

- A. Electrical equipment, unless specifically excluded herein, shall conform to the standards of the National Electrical Manufacturers Association (NEMA), National Fire Protection Association (NFPA), Underwriters Laboratories (UL), the National Electrical Testing Association, Inc. (NETA) wherever applicable.

- B. Materials and workmanship, unless specifically excluded herein, shall conform to the requirements of the National Electrical Code; California Administrative Code, Title 8, Chapter 4, Subchapter 5, Electrical Safety Orders; SCRRRA Engineering Standards, and any applicable local ordinances.
- C. The following General Orders (GO) or the most current General Orders of the State of California Public Utilities Commission (CPUC) shall apply:
  - 1. GO 52 Construction and Operation of Power and Communication Lines for the Prevention or Mitigation of Inductive Interference
  - 2. GO 118 Construction, Reconstruction and Maintenance of Walkways and Control, of Vegetation Adjacent to Railroad Tracks
  - 3. GO 128 Construction of Underground Electric Supply and Communication Systems
- D. The following parts of the Code of Federal Regulations, Title 47, Telecommunication, shall apply:
  - 1. Part 17 Construction, Marking and Lighting of Antenna Structures
  - 2. Part 90 Private Land Mobile Radio Services
  - 3. Part 101 Fixed Microwave Services
- E. The following parts of the Code of Federal Regulations, Title 49, Transportation, shall apply:
  - 1. Part 212 State Safety Participation Regulations
  - 2. Part 219 Control of Alcohol and Drug Use
  - 3. Part 218 Railroad Operating Practices
  - 4. Part 234 Grade Crossing Signal System Safety
  - 5. Part 236 Rules, Standards, and Instructions for Railroad Signal System
  - 6. Be responsible for adherence to all of the above rules and reporting requirements, including those regulations which require pre-employment drug testing and random drug testing of employees engaged in the installation and testing of communication facilities, and the reporting and tracking of employees injured in the performance of work on a railroad.
- F. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Communications and Signals (C&S) Manual



**1.04 SYSTEM DESCRIPTION**

- A. Reference ES9005 for high level overview of the SCRRRA Communication System.
- B. Provide all materials, software, licenses, installation services, testing and certification required for complete working integrated communication systems and subsystems, as described herein, and as shown on the Contract Plans, including any equipment not designated as being relocated or designated as Owner-furnished or in these specifications.
- C. All materials and equipment for installation and for interconnection of the various communications systems shall be fabricated, furnished, and installed as indicated on the Contract Plans and specified herein.
- D. The Contract Plans represent a final design utilizing systems, components, and materials that meet the Contract Specifications. Contractor may provide equivalent systems, components, and materials subject to the approval of the Engineer. If equivalent systems, components, and materials are provided, the Contractor shall provide an alternate detailed final design as specified herein under Design Submittals.
- E. All systems meetings held with the Engineer shall be attended by a Communications Engineer qualified in the application of the systems equipment the Contractor proposes for use on this project. Refer to Section 01 43 23, Contractor Qualifications and Requirements, and additional requirements specified herein.
- F. No circuit is considered to have met the requirement of these Specifications for function and safety until it has been properly tested and verified in the field. Any circuit changes made to meet the functional and safety requirements of these Specifications shall be considered as included as part of the work.
- G. Provide continuous or parallel communications during all phases of construction, testing and commissioning for existing systems. At no time shall the work cause delay to train operation, cause an unsafe condition, or reduce the effectiveness or quality of existing communication systems. Submit for approval by the Engineer the proposed Construction Sequencing Plan for providing alternate method of communications whenever the existing systems are deactivated, altered, or modified to accommodate construction work.
- H. Refer to Section 01 78 39, Project Record Documents, and additional requirements specified herein. Record the final As-Built conditions of the communication systems for each system.
- I. Coordinate installation, inspection, and testing of new Owner-furnished material with the Engineer. Notify the Engineer in writing 30 days prior to any installation, inspection, and testing as part of this coordination.
- J. The Contractor may encounter equipment placement conflicts during installation. In case of conflict, the Engineer will determine the correct placement.

- K. Perform or support acceptance testing and commissioning of the commissioning system as indicated in the Contract Plans.
- L. Contractor furnished software and components shall be new and manufacturer certified.
- M. Remove, salvage, retire or relocate project related equipment as indicated in the Contract Documents and as required to complete the Work. All equipment designated for disposal shall be done in accordance with local and state regulations.
- N. Refer to Section 31 20 00, Earthwork, for provisions for excavation and requirements for shoring of excavation as specified in Section 31 23 50, Excavation Support Systems.
- O. Protect existing communications cabling and, where necessary, relocate existing cabling to prevent damage during track installation and surfacing. If the Contractor damages existing cabling during construction, the Contractor shall be responsible for all Engineer approved repairs, testing and replacement of existing cabling.
- P. Refer to Section 01 14 49, Coordination with Utility Owners, for requirements in locating and protecting existing utilities.

#### **1.05 ENVIRONMENTAL PARAMETERS FOR EQUIPMENT**

- A. Contractor provided material and equipment shall be fully operable with no impairment resulting from the effect of the environment throughout the range of worst values indicated below. The general operating environment shall be in salty atmosphere and in generally sunny weather.
- B. Ambient outdoor temperature range: -40 degrees C to +70 degrees C.
- C. Relative humidity range: From zero to 100 percent.
- D. Maximum rainfall: 4 inches in 24 hours and 1.5 inches in 1 hour.
- E. Maximum wind velocity: 100 miles per hour.
- F. Seismic Design Category F.
- G. Isokeraunic Level: 5 strikes/km<sup>2</sup> per year.

#### **1.06 SUBMITTALS**

- A. All submittals required herein apply to all communications work shown within the Contract Plans. Refer to the specific communications subsystem specification for additional submittal requirements that are specific to the subsystem.
- B. No related work can begin without the prior submittal and Engineer approval of the personnel, material, plans and procedures.

- C. Submit resume(s) of the Communications Engineer(s) who will oversee the related work.
- D. Submit resume of all personnel who will perform splicing as a Fiber Splice Technician(s).
- E. Submit any proposed substitutions for equivalence evaluation by the Engineer within 30 days of Notice to Proceed.
- F. Submit a comprehensive Bill of Materials for all communications systems equipment.
- G. Submit a complete Network Device List for all Local Area Network (LAN) devices that will be added or removed by the project 30 days prior to scheduled installation.
- H. Submit a Construction Sequencing Plan to demonstrate how communication systems will remain operable.
- I. Submit a Test and Commissioning Plan for all communications systems that will be impacted by the project 30 days prior to the scheduled installation.
- J. Submit a Training Plan for all communications systems.
- K. Submit Asbuilt Documentation 30 days after communications systems have been commissioned.

#### **1.07 QUALIFICATIONS OF COMMUNICATIONS ENGINEER(S)**

- A. The Communications Engineer(s) shall be engaged in the bill of material generation, material inspection, installation, configuration, testing and commissioning of the various systems shall be qualified and have had experience in the type and level of work as required herein and by the Contract Plans. Once accepted, any replacement of these key employees shall be subject to the approval of the Engineer.
- B. The communications systems represented in the Contract Plans are broad and the experience of a single Communications Engineer may not encompass all systems. When this occurs, the Contractor shall submit more than one candidate to collectively demonstrate experience in all systems being constructed. In this case each Engineer shall coordinate under a designated Lead Engineer.
- C. Detailed Qualifications
  - 1. Networks
    - a. Bachelor degree preferred, in computer science, information technology or related field of study with an engineering focus. In lieu of degree, 5 years of additional working experience will be considered.

- b. Demonstrated 5-year minimum experience working with mission critical networks.
  - c. Strong understanding of Wide Area Network (WAN) and LAN network infrastructure that supports wireless, video, data and voice.
  - d. Ability to configure hardware.
  - e. Ability to test, troubleshoot, diagnose and resolve problems within the network.
  - f. Ability to produce systems documents required as Contract submittals.
2. RF (Radio Frequency)
- a. Bachelor degree preferred, in electrical engineering or related field of study with an engineering focus. In lieu of degree, 5 years of additional working experience will be considered.
  - b. Demonstrated 5-year minimum experience working with RF systems.
  - c. Ability to simulate RF links or predicted area of coverage using commercial off the shelf software.
  - d. Ability to complete and document RF site surveys.
  - e. Understands Federal Communications Commission (FCC) Regulatory Standards and can apply them in field deployments to ensure compliance.
  - f. Ability to configure hardware.
  - g. Ability to test, troubleshoot, diagnose and resolve problems within the RF links.
  - h. Ability to produce systems documents required as Contract submittals.
- D. Submittal Requirements
- 1. Resume(s) submitted shall demonstrate compliance with all systems being constructed or impacted by construction. Each resume submitted shall contain a cover page showing compliance with criteria herein.
  - 2. The lead Communications Engineer shall be identified.
  - 3. Engineer may request to interview individuals submitted.

**1.08 QUALIFICATIONS OF FIBER SPLICE TECHNICIAN(S)**

- A. The Fiber Splice Technician(s) shall be engaged in the fiber cable inspection, installation, splicing, testing and commissioning and shall be qualified and have had experience in the type and level of work as required herein and by the Contract Plans. Once accepted, any replacement of these key employees shall be subject to the approval of the Engineer.
- B. Detailed Qualifications
  - 1. Postsecondary education in electronics, telecommunications, or computer technology. In lieu of postsecondary education, 5 years of additional working experience will be considered.
  - 2. Demonstrated 5-year minimum experience splicing fiber.
  - 3. Fiber Optic Association (FOA) Fiber Optic Technician or equivalent certification.
  - 4. Ability to install, test, resolve and repair fiber optic cables.
- C. Submittal Requirements
  - 1. Resume(s) submitted shall demonstrate compliance with fiber being constructed, impacted by construction, or modified. Each resume submitted shall contain a cover page showing compliance with criteria herein.
  - 2. Fiber Optic Association Fiber Optic Technician or equivalent certificate.

**1.09 BILL OF MATERIALS**

- A. The lead Communications Engineer shall generate a master Bill of Materials for the communications systems.
- B. The Bill of Materials shall:
  - 1. Be generated as a spreadsheet in Excel.
  - 2. Be arranged by subsystem within the rows of the spreadsheet.
  - 3. Columns within the spreadsheet shall contain the following information:
    - a. Equipment Description
    - b. Manufacturer
    - c. Manufacturer Part Number
    - d. Total Quantity
    - e. Installation location

## f. Quantity by location

**1.10 NETWORK DEVICE LIST**

- A. The lead Communications Engineer shall generate a Network Device List for the communications systems. This will serve as the basis for obtaining IP address assignments from SCRRRA and other pertinent configuration information.
- B. The Network Device List shall:
  - 1. Be generated as a spreadsheet in Excel.
  - 2. Be arranged by location within the rows of the spreadsheet. Within each location, all equipment that requires an IP address assignment or other unique configuration information shall be identified.
  - 3. Blank columns within the spreadsheet shall contain the following minimum information:
    - a. IP Address
    - b. Network Mask
    - c. Gateway

**1.11 CONSTRUCTION SEQUENCING PLAN**

- A. The lead Communications Engineer shall prepare and submit a Communications Construction Sequencing Plan for each phase of construction where the communications system is to be modified, installed, or removed.
- B. The Communications Construction Sequencing Plan shall contain the following:
  - 1. Construction Phase
    - a. Identify high level project pre-requisites that are necessary before communications work within this phase can begin.
    - b. Provide a high level description of the objective for the communications system. Identify the outcome (what state the system will be in) once this phase is complete. If all original levels of network redundancy will not be supported during this phase, identify the risks and mitigating actions necessary.
    - c. Identify all locations that are impacted (added, modified, removed) by this phase.
  - 2. Location Specific Information
    - a. For each location that is to be added, modified, or removed provide:

- 1) A step-by-step sequence of work description which identifies those steps during which the existing system will be disabled, and a description of what steps will be taken to assure that the communications system will be tested and returned to full operation without causing a delay to any train movement.
  - 2) An estimate of time to complete the critical steps in the sequence specified in step-by-step sequence of work description.
- C. Should the construction phasing change during the project in a way that impacts the communications systems, that Contractor shall submit an updated Communications Construction Sequencing Plan.

### **1.12 INSPECTION, TEST AND COMMISSIONING PLAN**

- A. The lead Communications Engineer shall prepare an Inspection, Test and Commissioning Plan that outlines the Contractor's overall approach to testing and schedule. The Inspection, Test and Commissioning Plan shall also identify the Test Procedures that are necessary to be generated and submitted for approval. Requirements for specific Test Procedures are found within the subsystem specifications.
- B. Depending on the scope of the communications work, all phases of testing may not be applicable. The lead Communications Engineer shall evaluate the testing required in context with the communications work defined in the Contract Plans.
- C. The following definitions shall be used to communicate the phases of testing:
1. Factory Inspection
    - a. Contractor attends a factory inspection of the equipment prior to shipment to the construction site.
  2. Rack Testing
    - a. Contractor installs configured equipment into temporary racks at their facility to demonstrate subsystem(s) and interoperation prior to field deployment.
  3. Field Installation Inspection
    - a. Contractor inspects equipment post installation for conformance with installation standards and specifications.
  4. Field LAN Subsystem Testing
    - a. Contractor completes all tests that can be performed at the subsystem level without a WAN connection.

5. Field WAN System Testing
    - a. Contractor integrates all subsystems and perform WAN tests, while remaining network isolated from the Pomona DOC.
  6. Commissioning into SCRRA system
    - a. Contractor supports SCRRA to incrementally add systems and devices to their overall network, becoming visible from the Pomona DOC.
- D. The Inspection, Test and Commissioning Plan shall contain the following:
1. Summary Narrative
    - a. Provide a summary of the communications work and subsystems impacted by the project.
  2. Summary Table
    - a. A table summarizing each subsystem subject to inspection or testing.
    - b. The rows of the Summary Table shall be organized by subsystem. Possible subsystems that require testing include:
      - 1) Communications Shelter
      - 2) Power and Standby Power
      - 3) Data Radio Network
      - 4) Voice Radio Network
      - 5) Positive Train Control (PTC)
      - 6) Customer Information Systems
      - 7) Video Surveillance Systems
      - 8) Wide Area Networks
    - c. The columns of the Summary Table shall contain the following information:
      - 1) Factory Inspection
      - 2) Rack Testing
      - 3) Field Installation Inspection
      - 4) Field LAN Subsystem Testing



- 5) Field WAN System Testing
- 6) Commissioning into SCRRA system
- d. For each row/column intersection, list the following:
  - 1) Inspection Report or Check Off List, as applicable.
  - 2) Title(s) of the proposed Test Procedure(s) as applicable.
3. Integration Flow Chart
  - a. Include a flow chart that provides a visual representation of the subsystems and their dependencies throughout the project. An example of a dependency could be the ATCS Data Radio's dependency on the availability of power at a newly constructed site.
  - b. The Flow Chart shall conform with the following:
    - 1) Flow Chart shall be from left to right or from top to bottom.
    - 2) Use the correct symbol for each step:
      - a) Ovals for terminator (start/end steps).
      - b) Rectangles for subsystems.
      - c) Diamonds for decisions.
      - d) Arrows to represent flow and dependencies.

### 1.13 TRAINING PLAN

- A. The lead Communications Engineer shall prepare a Training Plan that outlines the Contractor's overall approach to training and schedule.
- B. Depending on the scope of the communications work, a Training Plan may not be required. The lead Communications Engineer shall evaluate the training required in context with the communications work defined in the Contract Plans.
- C. Comprehensive training shall be provided for all equipment that is accepted as equivalent, at no additional cost to SCRRA.
- D. Training Requirements:
  1. Training shall be held at SCRRA's Pomona, CA location. The training instructor(s) shall complete the training on site.
  2. A minimum of 4 training sessions shall be held for each Training Course. The training dates for each Training Course shall not be consecutive.

3. Each training session shall allow up to 8 SCRRA individuals to attend. Minimum training session durations shall be 8 hours for classroom time and 4 hours for lab time.
  4. Four sets of lab equipment (1 equipment set per 2 students) shall be provided during the training sessions. Upon completion of the training, the lab equipment will be given to SCRRA as spare equipment.
  5. Each training class shall include paper handouts and all materials provided on a USB flash drive for each student.
- E. Training Plan Requirements:
1. Identification of all required Training Courses.
  2. Resume of the instructor(s). The trainer shall be knowledgeable and qualified to teach each Training Course. Multiple trainer resumes shall be submitted if necessary.
  3. Proposed Training Course Schedule.
  4. For each Training Course, all proposed training materials shall be submitted including at a minimum:
    - a. Course Objective
    - b. Course Outline
    - c. Technical Theory
    - d. Installation Best Practices
    - e. Operation and Maintenance
    - f. SCRRA Application
      - 1) Provide context that is specific to SCRRA's use of the equipment.
    - g. Hands on Laboratory Session

#### **1.14 ASBUILT DOCUMENTATION**

- A. After a location is placed in service and prior to final acceptance of the project, the Contractor shall submit the following as-built documentation within 3 business days:
1. Drawing annotations
  2. Configuration files

- B. Annotate the As-Built drawing sets to show all approved circuiting and wiring changes made during installation and testing of the location prior to placing it in service, and any approved changes made after placement in service. Clearly identify all changes on the Drawings using the "Red In"/"Yellow Out" convention. Changes shall be dated and initialed by the Contractor's Communications Engineer.
- C. The final as-built Drawings shall be 11 inches by 17 inches.

#### **1.15 BID ITEM LIST**

- A. Submit the Bid Item List for communications bid items as required under Section 01 29 73, Schedule of Values, and in accordance with the following additional requirements:
  - 1. Bid Item List for the communications bid items shall include all interface circuits and staging necessary to place the location in service at each stage, all acceptance testing and transportation of materials, all equipment rental, all pretesting and removal of old equipment.
  - 2. Organize Bid Item List for communications bid items to assign a value to each communications location. A location is defined as a grade crossing warning system, an intermediate signal location, a Control Point, or a communications shelter.

#### **1.16 WARRANTY**

- A. Provide warranties for all equipment and material covering parts and labor for two years from the date equipment or material is "placed in service".

### **PART 2 - PRODUCTS**

**NOT USED**

### **PART 3 - EXECUTION**

**NOT USED**

### **PART 4 - MEASUREMENT AND PAYMENT**

#### **4.01 MEASUREMENT**

- A. Railroad Communications Requirements 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. Demolition and Removal of Existing Equipment 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. Railroad Communications Requirements 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.
- C. Demolition and Removal of Existing Equipment 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 34 44 00**

## SECTION 34 44 05

### COMMUNICATIONS BASIC EQUIPMENT, MATERIALS, AND METHODS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. The work in this Section describes the technical requirements for products and miscellaneous components to be provided, installed, and tested to support the organization of communications subsystems.
- B. This Section also describes requirements for labeling all communications cable, wire and equipment installed.

##### 1.02 RELATED SECTIONS

- A. Related Specification Sections include but are not limited to:
  - 1. 34 44 00 Railroad Communications Requirements
  - 2. 34 44 10 Prefabricated Communications Shelter
  - 3. 34 44 20 Communications Wire and Cable

##### 1.03 REFERENCES

- A. ANSI/TIA-606-B - Administration Standard for Telecommunications Infrastructure (Note this label standard is modified herein to use equipment abbreviations as a substitution for rack units. In the railroad wayside environment, not all enclosures use EIA rack units, nor have identifying markings for rack units)
- B. UL-497 - Primary Protector for Communications Circuits
- C. UL-969 - Standard for Safety of Marking and Labeling Systems

##### 1.04 SUBMITTALS

- A. Submit cut sheets for all proposed products that meet the specifications of this Section.
- B. Submit and demonstrate product samples when requested by the Engineer.
- C. Submit labeling for all Inside Plant cable and wire installed within the communications shelter or enclosure.
- D. Submit labeling for all installed Outside Plant communications cable.

## 1.05 INSIDE PLANT LABELING

### A. Equipment, Cables and Wires

#### 1. Equipment

- a. Non-modular equipment and modular chassis shall have a label applied with its Abbreviation Code.
- b. Modular equipment shall have labels applied to all modules used. Examples of this include:

- 1) Label voltage on split bus breaker panels. For example, "24VDC" and "12VDC".
- 2) At each breaker within a breaker panel, apply a label using the equipment abbreviation above the breaker. For example, the 15A breaker powering the Jumbo switch will be labeled "JUMBO".
- 3) At each Fiber Distribution Panel (FDP), apply labels on the cover panel when rack mounted or the metal body when wall mounts that define each card and identify the destination of the fibers. For example, at CP Bake: Card A would be labeled "CARD A – F5-8 Irvine STATION"; Card M would be labeled "CARD M – F5-8 CP Crown"

2. Cable identification labels shall be installed on each end of the communications cable, including wires, where they terminate on terminals, punch down blocks and connectors. If simplex fiber patch cords are used, or if the duplex clip is removed, label each end connection separately.
3. Cable identification labels shall be installed of each end of the electrical wire providing power within communications facilities and equipment.

### B. Labeling Convention

1. <Rack or Wall>-<Equipment Abbreviation>-<Card or Slot Number, If Applicable>-<Port Number>/<Rack or Wall>-<Equipment Abbreviation>-<Card or Slot Number, If Applicable>-<Port Number>
2. Convention begins at the originating end, where the cable is connected.
3. "/" is the separator used after the originating end detail and means "TO".
4. Convention ends at the far end, where the cable is terminated.
5. An example is "R101-FDP-A-1.2/R101-JUMBO-1-1"
6. Refer to ES9530-02.

### C. Communications Shelter Rack or Wall Assignments

1. Beginning from the right side of the communications shelter (when facing from the entrance door) and moving towards the left side, racks shall be assigned numbers starting with "101", "102", "103", etc. If there is space designated for future racks to be installed, their assigned number shall be reserved.
2. If the equipment is mounted on a wall, refer to ES9400-01 (Single Tenant Shelter) or ES9405-01 (Dual Tenant Shelter) for wall assignments of A, B, C, or D.

D. Typical Equipment Abbreviations

1. "12CHG", 12V Charger
2. "24CHG", 24V Charger
3. "48CHG", 48V Charger
4. "48CHGA", 48V Charger A
5. "48CHGB", 48V Charger B
6. "12BAT+", 12V Battery Plant Positive Terminal
7. "12BAT-", 12V Battery Plant Negative Terminal
8. "GNDBAR", Ground Bar
9. "SPM", Site Power Monitor
10. "UPS", Uninterruptible Power Supply
11. "BKRPNL", Breaker Panel
12. "FDP#", Fiber Distribution Panel
13. "JUMBO", Jumboswitch
14. "ROUTR", Router
15. "FR5000", VHF Radio
16. "CNA", ATCS Radio to Fiber Device
17. "BCM", ATCS Base Communications Module
18. "MTR3000", ATCS Base Radio
19. "PTC220", PTC Base Radio

20. Any equipment not defined within this list shall be assigned an abbreviation not exceeding 6 characters. The abbreviation shall be recognizable as the equipment described.

E. Card or Slot Number

1. This field is used when the equipment from which the cable originates from or is destined for is modular. To determine card or slot numbers, the equipment silkscreen identifiers shall be used. If there are no silkscreen identifiers, the equipment manual shall define the card or slot number assignments.

F. Port Number

1. This field is used when the equipment from which the cable originates from or is destined for is modular. To determine card or slot numbers, the equipment silkscreen identifiers shall be used. If there are no silkscreen identifiers, the equipment manual shall define the card or slot number assignments.

## 1.06 OUTSIDE PLANT LABELING

A. Backhaul Fiber Optic Cable, Outside Plant Label Convention

1. Labeling shall conform with the Fiber Route Diagram information for each Subdivision, which provides cable segment and site codes.
2. In every pull box that contains the Backbone Cable, the following convention shall be used:
  - a. FIBER BACKBONE <Cable Segment ID>
3. When a fiber cable lateral is in a pull box, the following convention shall be used:
  - a. <Pull Box Site Code>-FSE-<Fiber Cable Strand Count>-<Cable Segment ID>-L#<Lateral Number>/<Location Site Code>-<Fiber Distribution Panel Number>
  - b. An example is "SGV56.11-FSE-FS72-SG100-L1/CP56.1-FDP"
4. When a fiber cable lateral is in an enclosure, the following convention shall be used:
  - a. <Location Site Code>-<Fiber Distribution Panel Number>-<Fiber Cable Strand Count>-<Cable Segment ID>-L#<Lateral Number>/<Pull Box Site Code>-<Fiber Splice Enclosure Number>-<Fiber Backbone Buffer Tube Number Spliced>
  - b. An example is "CP56.1-FDP-FS72-SG100-L1/SGV56.11-FSE-1"
5. Cable Segment ID



- a. Cable Segments shall identify the Subdivision (XX) in which they are located:
    - 1) Code "SG", San Gabriel Subdivision
    - 2) Code "PV", Perris Valley Subdivision
    - 3) Code "RI", River Subdivision
    - 4) Code "VY", Valley Subdivision
    - 5) Code "VN", Ventura Subdivision
    - 6) Code "OR", Orange Subdivision
    - 7) Code "OL", Olive Subdivision
    - 8) Code "SW", Shortway Subdivision
  - b. A Segment ID (###) is a number assigned by the Fiber Route Diagram.
  - c. The code format is XX###
6. Location Site Code
- a. Site codes shall identify a Site Type (XX) at each location:
    - 1) Code "CP", Control Point
    - 2) Code "CX", Crossing
    - 3) Code "LS", Leaving Signal
    - 4) Code "ES", Electric Switch Lock
    - 5) Code "IM", Intermediate Signal
    - 6) Code "CS", Location with both Crossing and Signal functionality
    - 7) Code "CH", Communications Shelter/House
  - b. The location site code shall utilize a milepost to the tenth of a mile (MM.M) and the Site Type.
  - c. The code format is XXMM.M
7. Pull Box Site Codes

- a. The pull box site code (V) shall utilize a milepost to the nearest hundredth of a mile (MM.MM) of the pull box location and the Subdivision (XX). If there is more than one vault at the milepost location, vaults shall be labeled A, B, C, etc, working from Railroad West to Railroad East.
  - b. The code format is XXVMM.MM
- B. RF Cables Using Waveguide Entrance
  - 1. Labeling shall reference the system using the cable.
  - 2. The following convention shall be used:
    - a. <System>-<Cable\_Type>-/<Antenna Part Number>-<Antenna Length
    - b. An example is "VHF\_BASE-LDF4-50A/220-4N-20FT"

## **PART 2 - PRODUCTS**

### **2.01 INSIDE PLANT LABELS**

- A. Labels shall be a minimum of 0.75 inch in height and 1.5 inches wide.
- B. Label material
  - 1. Shall be UL listed.
  - 2. Shall have a white vinyl pressure-sensitive film with a minimum thickness 3.4mil.
  - 3. Shall utilize a permanent pressure-sensitive acrylic adhesive that bonds well to a variety of surfaces.
- C. Label printers
  - 1. Shall utilize thermal transfer printing.
  - 2. Shall utilize a UL approved ribbon.

### **2.02 OUTSIDE PLANT LABELS**

- A. Labels shall be suitable for the environmental conditions in which they are applied (such as moisture, heat, or ultraviolet light).
- B. Backhaul Fiber Cables
  - 1. Pre-printed yellow labels that state "CAUTION: FIBER OPTIC CABLE" shall be self-laminating made of rigid PVC material and a polyester self-sealing cover.

2. Label shall be approximately 2 inches in height and 3.5 inches wide.
  3. Under the cover of the yellow label, a white vinyl label meeting the requirements of inside plant label material and printing shall be applied.
- C. All other Outside Plant cables
1. Shall meet the requirements of Section 2.01 herein.

### **2.03 CABLE TIES AND VERTICAL CABLE SUPPORT**

- A. Zip ties
1. Shall made of Nylon 6/6 material.
  2. Shall be self-locking.
  3. For outdoor use shall be UV stabilized.
- B. Mounting Head Cable Ties
1. Shall made of Nylon 6/6 material.
- C. Rack Stand-Off Tie Bracket
1. Shall be made of high strength aluminum.
  2. Shall be 1 inch wide by 6 inches in length.
- D. Velcro Cable Ties
1. Shall be adjustable and reusable.
  2. Shall be self-gripping.

### **2.04 PUNCH DOWN BLOCKS**

- A. 110 Punch Down Block
1. Shall be used for 22 to 26 AWG wire using a punch down tool.
  2. Shall be capable of 500MHz (1 Gbps) or greater bandwidth.
  3. Shall have color coded wire strips that assist in wire sorting.
  4. Shall have jumper troughs sized to meet the cable minimum bend radius.

### **2.05 PROTECTED ENTRANCE TERMINALS**

- A. Outside Plant Entrance Cable Protected Entrance Terminals
1. Shall be made with 16 AWG power coated steel.

2. Shall have a cover and splice chamber.
  3. Shall accept 6 to 14 AWG wire for external ground connectors.
  4. Shall use an industry standard 5 pin design.
- B. Protector Modules
1. Shall be a 5 pin solid state module.
  2. Shall provide balanced protection, where an overvoltage on either side of the circuit will trigger the protection.
  3. Shall protect for voltages over 230 VDC.

## **2.06 HORIZONTAL CABLE MANAGEMENT**

- A. 19 Inch Rack Mountable Horizontal Cable Managers
1. Shall be compatible with two post rack systems.
  2. Shall come in rack units, minimum 1U.
  3. Shall contain fingers to separate and organize patch cords for adds, drops and modifications.
  4. Shall use snap on covers to hide routing.
  5. Covers and panel shall have a black powder coat finish.

## **2.07 EXECUTION**

## **2.08 INSTALLATION**

- A. Inside Plant Labels
1. Labeling shall be applied to all equipment, cables and wires installed by the Contractor.
  2. All labels shall be machine generated. No handwritten labels are allowed.
  3. Character size shall not be less than 1/8<sup>th</sup> inch in height, and not exceed 3 rows.
  4. Cables shall be labeled so that viewing shall not be obscured by cable bundling or dressing.
  5. At conduit entrance openings, labels shall be placed not less than 6 inches from the opening.
- B. Outside Plant Labels

1. Labeling shall be applied to all cable installed by the Contractor.
  2. All labels shall be machine generated. No handwritten labels are allowed.
  3. Cables shall be labeled so that viewing shall not be obscured by cable bundling or dressing.
  4. At conduit openings and from underground splice enclosure grommets, labels shall be placed not less than 6 inches from the opening or grommet.
  5. At waveguide openings labels shall be placed on either side (outside and inside shelter) of the waveguide. A label shall also be placed at the terminating equipment. All labels shall be placed not less than 6 inches from the waveguide or the terminating equipment.
- C. Cable Ties and Vertical Cable Support
1. Install in accordance with ES9440.
  2. Vertical cable support and standoffs shall be added to sufficiently support the cable weight and provide strain relief.
- D. Punch Down Blocks
1. Use Insulation Displacement Connection (punch down) termination.
  2. Use the proper tool to avoid damaging the connector.
  3. Punch down one single wire on each terminating clip. Do not punch down more than one wire per post.
  4. Leave enough slack for future removal and termination.
  5. Label all terminations.
  6. Test the connections/terminations.
- E. Protected Entrance Terminals
1. Locate terminal on backboard surface inside building as close as possible to cable entrance.
  2. Connect the terminal grounding to the Main Ground Bus.
  3. All protectors shall be fully inserted during testing.
- F. Horizontal Cable Management
1. Maintain the cable bend radius during installation.

**PART 3 - MEASUREMENT AND PAYMENT****3.01 MEASUREMENT**

- A. Communications Basic Equipment, Materials & 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.

**3.02 PAYMENT**

- A. Communications Base Equipment, Materials & 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 34 44 05**

## SECTION 34 44 10

### PREFABRICATED COMMUNICATIONS SHELTER

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. The work in this Section describes the technical requirements for products and miscellaneous components to be provided, installed and tested to support the housing of communications subsystems.
- B. After the shelter is installed at its final location, the Contractor shall install all equipment racks, wall mounted cable termination protections and other communications equipment where shown on the Plans.
- C. The Shelter type will be designated on the Plans as:
  - 1. Dual Tenant Shelter
    - a. This shelter type will house SCRRA and an identified third party.
    - b. The two areas shall be separated by a fence.
    - c. Each party shall have their own door for access.
    - d. The overall shelter dimensions shall be 10' x 20'.
  - 2. Single Tenant Shelter
    - a. This shelter type will house SCRRA only.
    - b. The overall shelter dimensions shall be 9' x 14'.

##### 1.02 RELATED SECTIONS

- A. Related Specification Sections include but are not limited to:
  - 1. 34 44 00 Railroad Communications Requirements
  - 2. 34 44 05 Communications Basic Equipment, Materials and Methods
  - 3. 34 44 20 Communications Wire and Cable

##### 1.03 REFERENCES

- A. ASCE 7-05, 7-10 – Minimum Design Loads for Buildings and Other Structures
- B. ASTM A36 – Standard Specification for Carbon Structural Steel

- C. ASTM A615 Grade 60– Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- D. ASTM A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed for Concrete
- E. ASTM C150 – Standard Specification for Portland Cement
- F. ASTM F3125 – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120ksi and 150 ksi Minimum tensile Strength and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
- G. ANSI/TIA 607-D– Generic Telecommunications Bonding and Grounding (Earthing for Customer Premises)
- H. NEC Article 242 – Overvoltage Protection
- I. UL 437 – Standard for Safety Key Locks
- J. UL 467 – Standard for Safety for Grounding and Bonding Equipment
- K. UL 752 – Standard to Bullet-Resisting Equipment

#### **1.04 SUBMITTALS**

- A. Submit Geotechnical Report for the area where the shelter will be installed.
- B. Submit Fabrication Drawings produced by the shelter manufacturer that show the following information:
  - 1. Floor Plan – overall dimensions and bill of materials.
  - 2. Exterior Elevations – exterior equipment placement, dimensions and bill of materials.
  - 3. Roof Plans – roof slope, cast in bolt pattern for antenna tripod mount, dimensions and bill of materials.
  - 4. Reflected Ceiling Plan – placement of overhead lighting, smoke and head detectors, electrical outlets, dimensions and bill of materials.
  - 5. Interior Elevations – interior equipment placement, dimensions and bill of materials.
  - 6. Cable Ladder Layout – placement of overhead cable ladder, Unistrut and dimensions.
  - 7. Electrical Panel – schedule for each panel, single line diagram and alarm wiring.



8. Foundation – Foundation designed by shelter manufacturer and sealed by a California Professional Structural Engineer.
- C. Submit and demonstrate product samples when requested by the Engineer.
- D. Submit the exterior finish paint color.
- E. Submit scheduled date of factory inspection of the communications shelter prior to shipping from the manufacturer to the final site. Submit verification report if the Engineer does not attend the factory inspection in person.
- F. Submit work plan for installation of shelter on its foundation.

## **PART 2 - PRODUCTS**

### **2.01 PREFABRICATED COMMUNICATION SHELTER**

- A. Structural
  1. Structure shall be fabricated from reinforced concrete panels.
  2. Walls and Roof
    - a. Concrete panels shall:
      - 1) Have minimum 4-inch thickness
      - 2) Have minimum 5000 psi compressive strength
      - 3) Have a minimum 2-hour fire rating
      - 4) Be reinforced with No. 4 rebar and No. 4 welded wire fabric
      - 5) Be bullet resistant
    - b. Roof shall:
      - 1) Have design loading (live load) of roof shall be minimum 80 pounds per square foot.
      - 2) Have proper slope for drainage and loading. Nominal drainage roof slop shall be 1/8 inch per foot.
      - 3) Be watertight. If the roof is seamed, a drip cap must be installed.
      - 4) Be capable of support a steel tripod with 7/8-inch diameter anchor bolts embedded into the roof structure to support a Valmont "S" Tripod up to 20' in height per ES9400-01.

- c. Wind design shall use a Basic Wind Speed of 110 mph, Exposure Category C.
  - d. Earthquake design shall use:
    - 1) Site Class D (or as modified by the Geotechnical Report)
    - 2) Design Category F
    - 3) Occupancy Category IV
    - 4) Seismic Force Resisting Systems, Wall Bearing Systems, Special Reinforced Concrete Shear Walls
3. Floor
- a. Floor concrete panels shall be a minimum of 6-inch thickness and shall be reinforced with No. 6 rebar and No. 4 welded wire fabric.
  - b. Shall have a design loading (live load) of a minimum 250 pounds per square foot.
  - c. Shall be reinforced with transverse, longitudinal and lateral ribs.
- B. Architectural
- 1. Exterior
    - a. Walls shall have a uniform exposed aggregate finish.
    - b. Wall shall be covered with an anti-graffiti sealer.
    - c. Walls shall be painted Desert Tan in color
    - d. All hardware and fasteners shall be tamper proof.
    - e. Roof shall have white elastomeric coating.
  - 2. Interior Walls and Ceiling
    - a. Finish Flame Spread Index shall be Class C.
    - b. Shall have 1.5" R11 Insulation covered by ½ inch Corrugated Plastic Core with a .030 Fiberglass Reinforced Plastic (FRP) overlay.
  - 3. Flooring
    - a. Floor finish shall be Critical Radiant Class I.
    - b. Shall use 12" x 12" Static Dissipative Tiles (SDT) with 1/8-inch thickness. Tile color shall be Ashgray.

- c. A color integrated 4-inch vinyl wall base shall be applied. Color shall be Midgray.
  - d. Adhesive shall be suitable for concrete.
- C. Cable ingress and egress
1. Void(s) shall be placed in the floor of the shelter for entrance conduits as indicated in the Plans.
  2. Waveguide window shall be placed in line with the interior cable ladder and support 4 cable entrance ports. Ports shall be 4-inch in diameter.
- D. Doors and Openings
1. Doors shall be single 3-foot by 7-foot.
  2. Door and frame shall be Level 4 rated Galvannealed Steel.
  3. Doors shall use a piano hinge.
  4. Lockset shall be mortise with changeable lock core.
  5. Door hardware shall include stainless steel hinges, anti-pick plate, hydraulic door closer with hold open arm, brush weather strip, aluminum threshold and door sweep.
  6. Doors shall have a drip cap with a minimum width of 2 inches.
  7. Doors shall have a stainless steel security bar.
- E. Electrical
1. Each tenant within the shelter shall be supplied with a minimum 100A 24 space integrated load center and Transient Voltage Surge Suppressor (TVSS) Type 2.
  2. The SCRRA tenant side shall incorporate and manual transfer switch and external 30A (NEMA L14-30R) Ground Fault Circuit Interrupter (GFI) receptacle.
  3. Duplex receptacles (20A) shall be installed at maximum intervals of approximately 4 feet along walls.
  4. Overhead twist-lock receptacles (NEMA L5-20R) shall be mounted on the ceiling near the Power rack (2) and near the Video Surveillance Systems rack (1).
  5. A minimum of one overhead twist-lock receptacle (240V, 30A) shall be mounted on the ceiling over the power rack.
  6. A duplex receptacle shall be provided for Emergency Exit Light.

7. A 240VAC, 30A circuit and fusible disconnect shall be provided for each HVAC unit.
- F. Heating Ventilation and Air Conditioning (HVAC)
1. Shall be 2-ton units, 20,000 BTU. Two units shall be provided.
  2. Shall use a non-ozone depleting refrigerant.
  3. Shall have wall mount adjustable supply and return grilles.
  4. Shall use a lead lag controller.
  5. Shall be protected with a heavy gauge, hot dipped, galvanized vandal-resistant security mesh cage with a swing door and lock.
- G. Alarms
1. The following dry contact alarms shall be monitored and wired:
    - a. Intrusion Detection
    - b. Smoke Detection
    - c. Power failure
    - d. High/Low temperature
    - e. AC failure
    - f. Humidity
    - g. Ionization
    - h. HVAC lockout
  2. Alarms shall be terminated on a 66-punch block.
- H. Lighting
1. Interior lighting shall be LED with acrylic lens cover. Light levels shall be adequate for reading.
  2. Exterior lighting shall be LED with motion detector.
  3. Emergency lighting shall include green illuminated exit sign, dual flood lights and battery backup of 90 minutes.
  4. Interior light switches shall be provided adjacent to the door(s) for both interior and exterior lighting.
- I. Cable Ladder

1. Cable ladder shall be 18" wide with 1 ½" stringer, yellow Zinc with hardware to anchor into concrete.

J. Grounding

1. Telecommunications Main Grounding Busbar (TMGB) shall be ¼" x 4" x 20" predrilled, electro-tin plated solid copper ground busbar with insulators and standoffs.

K. Additional Items

1. A plywood board, minimum 4' tall and ¾" thick, shall serve as the Main Distribution Frame (MDF) for each tenant. The board shall be painted white.
  - a. The SCRRRA tenant board shall be a minimum of 8' long.
  - b. The third-party tenant board shall be a minimum of 6' long.
2. A fire extinguisher 10lb carbon dioxide Class B C.
3. Wall mounted Document Holder
4. Ionization smoke detector
5. Photoelectric smoke detector
6. 10-person first aid kit, ANSI A
7. Eye wash station

## 2.02 ADDRESS SIGNAGE

- A. Each shelter shall be provided with address signage on the side of the exterior door for identification.
1. The sign shall have a white reflective background with 3 inch black lettering.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Foundation

1. Complete soil sample and geotechnical work before determining final foundation design.
2. Ensure foundation design includes voids to allow for entrance conduits into the shelter floor as shown in the Plans. Entrance conduits shall be placed near the vertical cable ladder and the MDF board.

- B. General
  - 1. All penetrations through the concrete walls shall be sealed to prevent water, insects and vermin from entering the shelter.
- C. HVAC
  - 1. Dual HVAC units shall be wired together to cycle (alternate) on-off during normal operation, or all one unit to operate should the other unit fail.
- D. Grounding
  - 1. One Telecommunications Main Grounding Busbar (TMGB) shall be installed a minimum of 72 inches above finished floor and attached with insulated brackets.
  - 2. Equipment, cables, and racks shall be grounded to this busbar as shown in the Plans.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Prefabricated Communications Shelter 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. Prefabricated Communications Shelter 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 factory acceptance testing, transportation, storage, assembly, delivery, permits and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

**END OF SECTION 34 44 10**

## SECTION 34 44 20

### COMMUNICATIONS WIRE AND CABLE

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. The work in this Section describes the technical requirements for products and supporting components for communications wire and cable to be furnished, installed, terminated and tested to support communications data transmission.
- B. Requirements for various cabling utilized by SCRRRA including fiber optic, coaxial, waveguide, and twisted pair are detailed herein.

##### 1.02 RELATED SECTIONS

- A. Related Specification Sections include but are not limited to:
  - 1. 34 44 00 Railroad Communications Requirements
  - 2. 34 44 05 Communications Basic Equipment Materials and Methods
  - 3. 34 44 10 Prefabricated Communications Shelter
  - 4. 34 44 50 Customer Information System
  - 5. 34 44 70 Wide Area Network
  - 6. 34 44 95 Data Radio Network

##### 1.03 REFERENCES

- A. ANSI/TIA-568.3-D Fiber Cabling and Components
- B. ANSI/ICEA S-87-640-2006, Standard for Fiber Optic Outside Plant Communications Cable
- C. ASTM E-814 - Standard Test Method for Fire Tests of Penetration Fire Stop Systems.
- D. International Organization of Standardization (ISO); 9001 Quality Management Services.
- E. United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 (PE-90), Specification for Filled Fiber Optic Cables
- F. GR-20-CORE, Generic Requirements for Optical Fiber and Optical Fiber

## 1.04 SUBMITTALS

- A. Submit cut sheets for all proposed products that meet the specifications of this Section.
- B. Submit installation and maintenance manuals for all cable and supporting equipment furnished.
- C. Prior to ordering any backhaul fiber optic cable, submit a fiber cable order plan that includes a complete listing of cable types, cable manufacturers, quantities, reel sizes and targeted location of installation within the project. The reel sizes shall include the required cable slack within the systems. An additional reel shall be ordered to account for 25% of total cable. This reel shall serve as a guardband and if not required by the contractor shall be submitted to SCRRA as spare material.
- D. For backhaul fiber optic cable, a detailed cable installation plan shall be submitted. The installation plan shall designate pull points,
- E. Submit Test Procedures for all newly installed or modified cable.
  - 1. Fiber Optic Cable
    - a. Use TIA-526-7 Method A.1 for singlemode cable.
      - 1) 1310nm
      - 2) 1550nm
    - b. Use TIA-526-14 for multimode cable
      - 1) 850nm
      - 2) 1300nm

## PART 2 - PRODUCTS

### 2.01 FIBER OPTIC CABLE

- A. Single Mode Fiber Optic Cable
  - 1. SCRRA standard single mode fiber optic backhaul cable shall be a minimum of 72 fiber optic strands and shall meet the following characteristics.
    - a. Loose tube cable of 250 um coated fiber suitable for duct, aerial and direct bury applications.
    - b. Dielectric central member that maintains bend radius.
    - c. Aramid yarn using SZ stranding to provide tensile strength.



- d. Gel-free, contains water swellable material.
- e. Contains ripcord for accessing core.
- f. Single corrugated steel armor used for toning cable.
- g. Polyethylene outer jacket with chemical, UV and abrasion resistance.
- h. Uses TIA-598-C optical fiber cable color coding.
- i. Optical fiber
  - 1) Compliant with ITU G.652.D fiber category.
  - 2) Exceed bend performance of ITU G.657.A1
  - 3) 1310nm
    - a) Maximum attenuation of 0.34dB/km
    - b) Maximum point discontinuity of 0.05dB
    - c) Mode field diameter of 9.2 +/- 0.4
    - d) Effective group index of refraction  $N_{eff}$  1.4676
    - e) Rayleigh backscatter coefficient (1ns pulse width) - 77dB
  - 4) 1550nm
    - a) Maximum attenuation of 0.22dB/km
    - b) Maximum point discontinuity of 0.05dB
    - c) Mode field diameter of 10.4 +/- 0.5
    - d) Dispersion maximum of 18 ps/(nm-km)
    - e) Effective group index of refraction  $N_{eff}$  1.4682
    - f) Rayleigh backscatter coefficient (1ns pulse width) - 82dB
  - 5) Core diameter of 8.2um
  - 6) Cladding diameter of 125 +/- 0.7um
  - 7) Core-clad concentricity maximum of 0.5um
  - 8) Coating-cladding concentricity maximum of 12um

2. Single mode patch cables shall utilize fiber that is compatible with the backhaul cables.
  - a. Typical SCRRA patch cables are:
    - 1) SC to SC connectors for fiber distribution panel cross connections.
    - 2) SC to LC connectors for connections to SFP lasers.
    - 3) Duplex configuration preferred.
  - b. All patch cords shall be factory made and tested.
  - c. Maximum insertion loss shall be 0.2dB.
  - d. Polish shall be UPC.
  - e. Jacketing shall be low smoke zero halogen.

B. Multimode Fiber Optic Cable

1. SCRRA standard multimode fiber optic station cable shall meet the following characteristics.
  - a. Loose tube cable of 250 um coated fiber suitable for duct, aerial and direct bury applications.
  - b. Uses TIA-598-C optical fiber cable color coding.
  - c. Optical fiber
    - 1) Compliant with TIA-568C
    - 2) Core diameter of 50um
    - 3) Cladding diameter of 125um
    - 4) 850nm
      - a) Maximum attenuation of 3dB/km
      - b) Minimum effective modal bandwidth of 4700 MHz\*km
    - 5) 1300nm
      - a) Maximum attenuation of 1dB/km
2. Multimode patch cables shall use fiber that is compatible with the station cables.

- a. Typical SCRRA patch cables are:
  - 1) SC to SC connectors for fiber distribution panel to media converter connections.
  - 2) Duplex configuration preferred.
- b. All patch cords shall be factory made and tested.
- c. Maximum insertion loss shall be 0.5dB.
- d. Polish shall be UPC.

## 2.02 FIBER OPTIC CABLE TERMINATION

- A. Indoor fiber optic cable termination shall:
  - 1. Be modular and support panel cards for SC and SC Duplex connectors.
  - 2. Panel cards shall support a minimum of 12 fiber strand connections.
  - 3. All panel cards shall have pigtails that are factory tested and fusion spliced to the backhaul or station fiber cable.
  - 4. Fiber cassette use is permissible only when all fibers are terminated within a cable.
  - 5. Fiber cassette use is not permissible if certain fiber strands within the cable are designated to be fusion spliced (west to east) within the signal or communications enclosure. These fibers cannot be physically spliced within the same cassette.
  - 6. Backhaul cable termination
    - a. Support 2 times the fiber strand count. For 72 strand fiber, fiber optic termination shall support 144 terminations.
    - b. Backhaul fiber distribution panels shall support backhaul cables only.
  - 7. Station cable termination
    - a. All fibers shall be terminated on a single panel.
    - b. Station fiber distribution panels shall support station cables only.
- B. Outdoor fiber optic cable termination shall:
  - 1. Be stored in an underground splice enclosure.
  - 2. Splice trays shall be sized to seat and store the maximum number of possible splices.

**2.03 TWISTED PAIR CABLE**

- A. Twisted pair cable shall:
1. Meet the cable category rating as indicated on the Drawings:
    - a. Category 3, up to 10Mbps
      - 1) 16MHz bandwidth
    - b. Category 5e, up to 1000Mbps
      - 1) 24 AWG
      - 2) 100MHz bandwidth
      - 3) Return loss of 20.1dB
      - 4) 100 ohm impedance
    - c. Category 6, up to 1000Mbps
      - 1) 23 AWG
      - 2) 250Mhz bandwidth
      - 3) Return loss of 20.1dB
      - 4) 100 ohm impedance
  2. Utilize copper wire.
  3. RS-422 cable
    - a. Sheilded
    - b. 22 AWG
    - c. 100 ohm impedance
    - d. Shunt capacitance of 16pF per foot
- B. Unshielded Twisted Pair (UTP) cable shall:
1. Meet ANSI/TIA-568 standards.
  2. Support a minimum of 4 pairs for Ethernet applications.
  3. Jacketing shall be low smoke zero halogen (LSZH).
  4. Be compatible with RJ45 connectors and punch down blocks.

5. All UTP patch cables shall be factory made and tested.
  6. All outdoor cables shall be UV rated.
- C. Shielded Twisted Pair (STP) cable shall:
1. Be confined in a foil or mesh shield that guards the cable against electromagnetic interference.
  2. Support a minimum of 4 pairs for Ethernet applications.
  3. Jacketing shall be low smoke zero halogen (LSZH).
  4. Be compatible with RJ45 connectors and punch down blocks.
  5. All STP patch cables shall be factory made and tested.
  6. All outdoor cables shall be UV rated.

#### **2.04 70V SPEAKER CABLE**

- A. The 70V speaker cable shall:
1. Use stranded copper
  2. Be a minimum of 16 AWG
  3. Unsheilded

#### **2.05 WAVEGUIDE**

- A. Elliptical waveguides shall:
1. Be compatible to the frequency licensed for the microwave link
    - a. EW63, 5.925Ghz to 7.125GHz
      - 1) Voltage Standing Wave Ratio (VSWR) 1.15
      - 2) Return loss 23.13dB
    - b. EW90, 10.2GHz to 11.7GHz
      - 1) Voltage Standing Wave Ratio (VSWR) 1.15 (up to 300 ft)
      - 2) Return loss 23.10dB
  2. Be constructed of corrugated copper.
  3. Have a polyethylene jacket.
- B. Flexible waveguides shall:

1. Be a helically wound silver coated brass strip for uniform construction.
2. Provide repeatable return loss and insertion loss performance during flexing.
3. Have a neoprene jacket to provide environmental and mechanical protection.
4. Be compatible to the frequency licensed for the microwave link.
  - a. WR137, 5.85GHz to 8.2GHz
  - b. WR90, 8.2GHz to 12.4GHz

## 2.06 COAXIAL CABLE

- A. Coaxial cable shall:
1. Have attenuation and power information for the frequency of the radio application.
  2. Be constructed of a center copper-clad aluminum wire, with a low density foam dielectric layer and a shield layer of corrugated copper.
  3. Have a cable impedance of 50 ohm +/- 1 ohm.
  4. Have a Voltage Standing Wave Ratio (VSWR) of 1.13
  5. Have a return loss of 24.3dB

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. General
1. Visually inspect all equipment for possible damage upon receipt and prior to installation. Do not install any damaged equipment.
  2. All equipment shall be installed in accordance with the manufacturer's recommendations.
  3. Route interface cables carefully to ensure cable bend radius is maintained throughout the installation.
  4. If intra enclosure cabling is required, shielded and grounded cables shall be used. Cables shall be grounded at both ends.
- B. Fiber Optic Cable

1. Use the proper eye protection when working on fiber optic cable. Never look directly into the end of any optical fiber unless certain that no light is present in the fiber.
  2. Optical fiber is sensitive to dust and dirt. Maintain the highest standards of cleanliness when working with fiber. Always keep dust caps on connectors, mating adapters, patch panels, or test equipment. Use lint free wips and pure reagent grade isopropyl alcohol to clean connectors.
  3. Conduct on-reel testing to verify the cable was not damaged during shipping.
  4. Prior to installation, survey the conduit and pull box locations in the field for creation of the pull plan. The pull plan shall include a copy of the manufacturer's installation recommendations.
  5. Swivel pulling eyes shall be used to attach the pulling rope to prevent cable twisting during the pull.
  6. Do not exceed the maximum pulling tension rating. Use a tension monitoring winch during installation and approved cable lubricants.
  7. When laying loops of fiber on a surface during a pull, use figure eight loops to prevent twisting the cable.
  8. For backhaul fiber, ensure a minimum of 150 feet of slack is provided in each pull box.
  9. During termination, all splices shall be fusion splices.
  10. Any metallic hardware used in fiber optic cable systems (such as the armor) shall be grounded.
  11. During OTDR testing, set the test pulse as short as possible for the range needed to reach the end of the cable for best resolution.
  12. During testing, measured losses shall not exceed:
    - a. 0.3dB for fusion splices
    - b. 0.5dB for mated connectors
- C. Twisted pair cable
1. Support cabling to prevent undue stress from its own weight. The cable shall be free of tension at both ends, as well as over the entire length of the run.
  2. Shielded cable shall be grounded and use surge protection.
- D. Waveguide

1. Waveguide shall be pressure tested by the manufacturer before shipping. Upon receipt, use a tire gauge to check pressure at the cable end.
  2. Use a hoist line that supports the total weight of the waveguide. Use a pulley high enough on the tower to allow the waveguide to be raised sufficiently to make the antenna connection. A winch is recommended for hoisting.
  3. Maintain hoist line tension until anchoring is completed.
  4. The top and bottom of the waveguide shall be grounded to the tower. The antenna input connection shall not serve as top ground. Ground the waveguide at the point where it enters the enclosure.
  5. After all connections have been completed, pressurize the waveguide using dry air. If moist air has entered the waveguide, it shall be purged. After purging, repressurize the waveguide.
  6. Check the final installation for leaks.
  7. Measure the following:
    - a. Cable loss (1 port)
    - b. Insertion loss
    - c. VSWR
- E. Coaxial Cable
1. The top and bottom of the coaxial cable shall be grounded to the tower. Ground the coaxial cable at the point where it enters the enclosure.
  2. Measure the following:
    - a. Cable loss (1 port)
    - b. Insertion loss
    - c. VSWR

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Communications Wire and Cable 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. Communications Wire and Cable 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 34 44 20**

## SECTION 34 44 50

### CUSTOMER INFORMATION SYSTEM

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. The work in this Section describes the technical requirements for products and supporting components to be furnished, installed and tested to support, extend or modify the Customer Information System (CIS).
- B. Requirements for various systems, methods and cabling utilized by SCRRA for Public Address, Real Time Messaging, Schedule Information, Ticket Vending and Emergency Management at Passenger Stations are detailed herein. The Pomona DOC is the SCRRA Operations Center.

##### 1.02 RELATED SECTIONS

- A. Related Specification Sections include but are not limited to:
  - 1. 34 44 00 Railroad Communications Requirements
  - 2. 34 44 05 Communications Basic Equipment Materials and Methods
  - 3. 34 44 10 Prefabricated Communications Shelter
  - 4. 34 44 20 Communications Wire and Cable
  - 5. 34 44 70 Wide Area Network

##### 1.03 REFERENCES

##### 1.04 SUBMITTALS

- A. Submit cut sheets for all proposed products that meet the specifications of this Section.
- B. Submit operation, installation, engineering and maintenance manuals for all equipment furnished.
- C. Submit Test Procedures for all new or modified systems.
- D. Public Address
  - 1. Submit Ambient Noise Baseline Measurement.
  - 2. Submit proposed configuration files:
    - a. Audio Controller

- b. Audio Processor
3. Submit final commissioned configuration files for all locations.

## **PART 2 - PRODUCTS**

### **2.01 CIS ETHERNET SWITCH**

- A. The CIS Ethernet Switch shall:
  1. Support the following operating temperatures:
    - a. 0 degrees C to +45 degrees C at climate-controlled Station locations.
  2. Support Field Replaceable Units
    - a. Power, a minimum of two AC modules.
  3. Support redundant fans for cooling. The switch shall be able to operate if one of the fans fail.
  4. Be capable of Gigabit Ethernet.
    - a. 24 10/100/1000 Copper ports with Power over Ethernet Plus (PoE+) capability with a minimum power of 600W.
    - b. Capable of per port power policing.
    - c. 4 SFP ports 1G/10G
  5. Support Perpetual PoE, which maintains power during a switch reboot.
  6. Have 56 Gbps of switching capacity.
  7. Shall support the following Standards:
    - a. 802.1s Multiple Spanning Tree Protocol
    - b. 802.1Q VLAN
    - c. 802.1p QoS
    - d. 802.1w RSTP
    - e. 802.1x Port Based Network Access Control
    - f. 802.3ad Link Aggregation
    - g. 802.3af PoE

- h. 802.3at PoE+
- 8. Have a minimum MTBF of 392,000 hours
- 9. Be capable of 19-inch rack mount.

## 2.02 CIS CONTROLLER

- A. The CIS Controller shall:
  - 1. Support the following operating temperatures:
    - a. 0 degrees C to +50 degrees C at climate-controlled Station locations.
  - 2. Be mountable on a 19-inch rack and occupy 1 rack unit.
  - 3. Support a 1 GB LAN connection.
  - 4. Have 6 USB 2.0 ports.
  - 5. Have 4 USB 3.1 ports.
  - 6. Have 4 GB DDR4 2666MHz memory.
  - 7. Support Realtek ALC887 codec to drive the Public Address Audio.

## 2.03 FIBER TO ETHERNET MODULAR MEDIA CONVERTER

- A. The Fiber to Ethernet Modular Media Converter shall:
  - 1. Support the following operating temperatures:
    - a. 0 degrees C to +50 degrees C at climate-controlled Station locations.
  - 2. Be chassis based to mount in a 19-inch rack and utilize slide in media converter cards.
  - 3. Be powered with redundant power supplies.
  - 4. Utilize remote management and feature control through a management module within the chassis via:
    - a. Web Browser
    - b. Telnet
    - c. SNMP
  - 5. Support multimode and singlemode fiber up to 100 Mbps.

6. Support Unshielded Twisted Pair (UTP) Ethernet copper connections up to 100 Mbps.
7. Support hot-swappable, Small Form Factor Pluggable (SFP) optics.

## 2.04 AUDIO SIGNAL PROCESSOR

- A. The Audio Signal Processor shall:
  1. Support configurable inputs and outputs (I/O) via a minimum of 4 card slots.
  2. Support the following types of I/O cards:
    - a. Analog Input Card
      - 1) Software configurable gain in 6dB steps up to +48dB per channel.
      - 2) Selectable 48V Phantom Power per channel.
    - b. Analog Output Card
    - c. Digital Input Card
      - 1) AES3 standard
    - d. Digital Output Card
      - 1) AES3 standard
    - e. Acoustic Echo Cancellation (AEC) Input Card
    - f. Telephone Hybrid Card
  3. Support configurable signal processing.
  4. Have a Dynamic Range of 105dB unweighted, 108dB A-weighted.
  5. Have a Total Harmonic Distortion figure less than 0.01%.
  6. Have control software supports audio processing objects to include:
    - a. Crossovers
    - b. Compressors
    - c. Gates
    - d. Duckers
    - e. Expanders

- f. Limiters
  - g. Gain blocks
  - h. Graphic Equalizers
  - i. Filters
  - j. Metering points
  - k. Delays
  - l. Mixers
  - m. Tone Generators
  - n. Source Selectors
- 7. Have password-based security with remote access via the Ethernet network.
  - 8. Be 19-inch rack mountable.
  - 9. Support HiQnet control protocol.

## **2.05 AUDIO AMPLIFIER**

- A. The Audio Amplifier shall:
  - 1. Support direct drive 70Vrms output.
  - 2. Support 4 channels of audio output.
  - 3. Support 300W of power to drive 70V speakers.
  - 4. Have a voltage gain of up to 34dB.
  - 5. Have Total Harmonic Distortion of 0.35%.
  - 6. Have an Analog Input Signal to Noise Ratio greater than 104dB.
  - 7. Have an Input Sensitivity of 1.4Vrms..
  - 8. Be 19-inch rack mountable.
  - 9. Have an Ethernet network port for remote monitoring and control.

## **2.06 AMBIENT NOISE SENSOR**

- A. The Ambient Noise Sensor shall:
  - 1. Be suitable for outdoors and weather resistant.

2. Support Phantom Powering.
3. Have a microphone of electret condenser type.
4. Have a typical Frequency Response of 80Hz to 10,000Hz.
5. Have a signal to noise ratio of 68dB at 94dB Sound Pressure Level.
6. Have polarity where positive pressure on the diaphragm produces positive voltage on the audio+ terminal with respect to the audio- terminal.
7. Support an operating temperature of -10 degrees C to +60 degrees C.

## **2.07 EMERGENCY MANAGEMENT PANEL**

- A. The Emergency Management Panel shall:
1. Be a dual access lockable free standing enclosure constructed of 12-gauge 316 stainless steel.
  2. Have telephone cable wired from the communications shelter and terminated on a 66 block.
  3. Have a handset connected to the 66 block.
  4. Have the ambient noise sensor connected to the 66 block.

## **2.08 LIGHT EMITTING DIODE (LED) MESSAGE SIGNS**

- A. The LED Message Signs shall:
1. Support the following operating temperatures:
    - a. -40 degrees C to +50 degrees C at 100% humidity.
  2. Have a minimum LED half-life of 100,000 hours and a minimum of 4000 cd/m<sup>2</sup> amber intensity.
  3. Automatically adjust to a minimum of 99 levels of brightness according to lighting conditions.
  4. Have a minimum 120 degree LED viewing angle.
  5. Have 8mm pitch pixels, 1600 pixels per square foot. The failure of a single pixel shall not cause failure of any other pixel in the display.
  6. Have interchangeable LED display modules with a quick-disconnect locking connector type.
  7. Be available in single face or double face (single cabinet) configurations controlled by a single controller.

8. Be powered by 120VAC with a main breaker.
9. Support RS422 and Ethernet (copper or fiber) communications.
10. Be rated NEMA 4X.
11. Have conformal coating on all electronic components.
12. Have front service access using a tamper resistant key entry system.
13. Support alphanumeric text in character sizes that meet ADA requirements.
14. Support presentation modes of steady, horizontal scroll, vertical scroll and flash.
15. Support a sunshade to maximize contrast of the display.
16. Use a protocol compatible with SCRRA's LED signage head end control software.
  - a. The data link protocol will use a check summing technique to guarantee packet integrity. Packets shall be discarded if the packet's check sum is not valid.
  - b. Displays shall not initiate communication on the network.
  - c. Each display shall be assigned a unique physical address and a group address.
  - d. Broadcast addressing will allow multiple displays to receive one packet.

## **2.09 TRAIN SCHEDULE DISPLAY MONITOR AND ENCLOSURE**

- A. The Train Schedule Display Monitor shall:
  1. Support the following operating temperatures:
    - a. 0 degrees C to +45 degrees C.
  2. Be a 49-inch display.
  3. Have a native resolution of 1920x1080.
  4. Support a minimum brightness of 3500 nits.
  5. Have a minimum 178 degree viewing angle.
  6. Have a minimum light lifetime of 100,000 hours.
  7. Have a minimum contrast ratio of 3000:1.



8. Support a landscape orientation.
  9. Support 400x400 VESA mounting.
  10. Be fanless.
  11. Support HDMI and DVI inputs.
- B. The Train Schedule Display Monitor Enclosure shall:
1. Be a standalone enclosure with a post and arm extension that supports concealed cable routing.
  2. Contain a sunshield.
  3. Place the bottom of the display at a minimum height of 7 feet to prevent public access and vandalism.
  4. Support a VESA standard display mount.
  5. Support a 49-inch display.
  6. Support a tilt angle of 15 degrees.
  7. Provide an integrated 4000 BTU air conditioner.
  8. Support 120VAC power for display.
  9. Support storage of fiber patch panel, media converter and monitor controller.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. General
1. Visually inspect all equipment for possible damage upon receipt and prior to installation. Do not install any damaged equipment.
  2. All equipment shall be installed in accordance with the manufacturer's recommendations.
  3. All equipment chassis shall be grounded to the main ground within the enclosure. Use a separate ground cable for each equipment instance. If equipment is grounded to the rack, verify that the rack is connected to the main ground. Do not assume that an existing rack is correctly grounded.
  4. Mount equipment with clearance to allow for proper ventilation and air flow.

5. Route interface cables carefully to ensure cable bend radius is maintained throughout the installation.
  6. If intra enclosure cabling is required, shielded and grounded cables shall be used. Cables shall be grounded at both ends.
- B. CIS Ethernet Switch
1. All device IP assigned under the CIS subnet shall be connected to the CIS Ethernet switch.
- C. Fiber to Ethernet Modular Media Converter
1. Install chassis slot covers on all unused slots.
  2. Install cards in accordance with the assigned slots in the Contract Drawings.
  3. All patch cables shall be installed neatly using vertical or horizontal cable management.
- D. Audio Signal Processor
1. Use balanced wiring connections for the I/O card.
- E. Audio Amplifier
1. When powering a fully configurate Public Address system, always turn the amplifiers on last and off first.
  2. Configure the amplifier for 70V output mode, Dual mode, High Z.
  3. Use prebuilt balanced cables (2 conductor plus shield). Balanced wiring provides better rejection of unwanted noise and hum.
  4. Maintain proper polarity on output connectors.
- F. Ambient Noise Sensor
1. Install Ambient Noise Sensor on platform pole or canopy near area where trains stop. House in an electrical outlet box with 2-inch minimum depth.
  2. Run a 2-conductor shielded mic cable from the Audio Signal Processor to the area where the sensor will be installed. Enable phantom power at the Audio Signal Processor.
- G. LED Message Signs
1. Prior to installation, confirm the designated structure and mounting hardware are adequate to support the display size and weight.
  2. All mounted displays shall be inspected by a qualified structural engineer.

3. Displays shall be grounded to earth ground.
  4. For cable interconnections between signs shown in a back-to-back configuration, use liquid tight flexible conduit.
- H. Train Schedule Display Monitor and Enclosure
1. Power for the monitor enclosure shall be provided from the station electrical distribution panel.
  2. Ensure placement meets ADA requirements for protruding objects and minimum ground space to navigate around the enclosure.
- I. Testing
1. Utilize the CIS switch to perform local testing of each system.
    - a. LED Message Signs
      - 1) Verify all signs can display test messages from local laptop.
    - b. Public Address & Emergency Management Panel (EMP)
      - 1) Test audio and measure sound levels comparing to Baseline Ambient Noise measurement.
      - 2) Test EMP functionality
      - 3) Test functionality of ambient noise sensor when a locomotive is in the station.
    - c. Train Schedule Display Monitor
      - 1) Verify monitor can display test messages from a local laptop.
    - d. TVM
      - 1) Verify connectivity (ping test) from a local laptop.
  2. Coordinate with the CIS help desk to perform testing with the head end systems located at the Pomona MOC/DOC.
    - a. LED Message Signs
      - 1) Verify all signs can display remove messages from the head end system.
    - b. Public Address & Emergency Management Panel (EMP)
      - 1) Test remote audio and measure sound levels comparing to Baseline Ambient Noise measurement.

- 2) Test EMP functionality and priority selection over remote audio.
  - 3) Test functionality of ambient noise sensor when a locomotive is in the station.
- c. Train Schedule Display Monitor
- 1) Verify monitor can display messages from the head end system.
- d. TVM
- 1) Verify a ticket can be purchased using each machine.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Customer Information 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. Customer Information 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. 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 34 44 50**

**SECTION 34 44 70**  
**WIDE AREA NETWORK**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. The work in this Section describes the technical requirements for products and supporting components to be furnished, installed and tested to support, extend or modify the Wide Area Network (WAN).
- B. Requirements for various WAN technologies deployed and utilized by SCRRA including Fiber, Microwave, and Cellular are detailed herein. The Pomona DOC is the SCRRA Operations Center.

**1.02 RELATED SECTIONS**

- A. Related Specification Sections include but are not limited to:
  - 1. 34 44 00 Railroad Communications Requirements
  - 2. 34 44 05 Communications Basic Equipment Materials and Methods
  - 3. 34 44 10 Prefabricated Communications Shelter
  - 4. 34 44 20 Communications Wire and Cable
  - 5. 34 44 95 Data Radio Networks

**1.03 REFERENCES**

- A. IEEE 802.1D – MAC Bridges
- B. IEEE 802.1p – Quality of Service (QoS)
- C. IEEE 802.1Q – Virtual LAN (VLAN) Tagging
- D. IEEE 802.1w – Rapid Reconfiguration of Spanning Tree
- E. IEEE 802.1x – Port Based Network Access Control
- F. IEEE 802.3 - Ethernet
- G. IEEE 802.3u – Fast Ethernet
- H. IEEE 802.3x – Flow Control, Full Duplex
- I. IEEE 802.3z – Ethernet over fiber optic at 1 Gigabit (1000Base-X)

- J. IEEE 802.3ab – Ethernet over twisted pair at 1 Gigabit (1000Base-T)
- K. IEEE 802.3ad – Link Aggregation
- L. IEEE 802.3ae – 10 Gigabit Ethernet over fiber
- M. ITU-T X.200 – Information Technology – Open Systems Interconnection – Basic Reference Model
- N. ITU G.694.1 – Spectral grids for WDM applications: DWDM frequency grid
- O. Telecordia Generic Requirements GR-63-CORE – NEBS Requirements: Physical Protection
- P. Telecordia Generic Requirements GR-1089-CORE – Electromagnetic Compatibility and Electrical Safety – Generic Criteria for Network Telecommunications Equipment

#### **1.04 SUBMITTALS**

- A. Submit cut sheets for all proposed products that meet the specifications of this Section.
- B. Submit operation, installation, engineering and maintenance manuals for all equipment furnished.
- C. The Plans have been prepared using Vendor specific equipment. Should the Contractor propose equivalent systems and they are approved by the Engineer, the Contractor shall update all Plans where the equipment is used at no additional cost.
- D. Train Control Fiber Optic WAN
  - 1. Submit Optical Link Budget calculations for all new and existing WAN nodes impacted by the project.
  - 2. Submit proposed configuration file for each type of location:
    - a. Station
    - b. Control Point
    - c. Intermediate
  - 3. Submit final commissioned configuration files for all locations.
- E. Microwave WAN
  - 1. Submit Line of Sight survey for each new microwave link.
- F. Security Data DWDM Fiber Optic WAN

1. Submit Optical Link Budget calculations for all new and existing WAN nodes impacted by the project.
2. Submit final commissioned configuration files for all locations.

## **PART 2 - PRODUCTS**

### **2.01 TRAIN CONTROL ETHERNET SWITCH**

- A. The Train Control Switch shall be TC Communications Model TC3840 JumboSwitch or Engineer approved equivalent.
  1. Approved Equivalent Additional Requirements (At no additional cost)
    - a. Contractor shall provide a comprehensive Network Management System (NMS) for the equivalent equipment that meets or exceeds the existing NMS, TCView.
    - b. Contractor shall provide training for the equivalent equipment per Section 34 44 00 Part 1.13.
    - c. Contractor shall provide a minimum of 10 spares of this equipment.
  2. Train Control Switch shall:
    - a. Support the following operating temperatures:
      - 1) -20 degrees C to +70 degrees C at climate-controlled Station locations.
      - 2) -40 degrees C to +70 degrees C at wayside signal locations.
    - b. Be hardened with no fans or other mechanical parts
    - c. Support the following network topologies:
      - 1) Mesh
      - 2) Ring
      - 3) Point to Point
    - d. Be capable of Gigabit Ethernet
      - 1) 1 Gbps (Layer 2 or Layer 3)
      - 2) Optical or Copper ports
    - e. Shall support the following Standards:
      - 1) 802.1Q VLAN

- 2) 802.1p QoS
  - 3) 802.1w RSTP
  - 4) 802.3ad Link Aggregation
  - 5) 802.1x Port Base Network Access Control
  - 6) Port Mirroring
  - 7) IGMP Snooping
  - 8) Port Rate Limiting
  - 9) Broadcast Storm Limiting
  - 10) NTP time synchronization
- f. Have a modular design with hot-swappable cards and redundant power supplies.
- g. Be capable of 19-inch rack mount.
- h. Support chassis flexibility and interface module slots for expansion:
- 1) 4U chassis
  - 2) 2U chassis
- i. Have dual load sharing power supplies:
- 1) AC 115/230V
  - 2) DC 12V, 24V, -48V
- j. Be capable of remote management with the following:
- 1) VLAN
  - 2) SNMP
  - 3) Serial Console
  - 4) Telnet
- k. Support the following Small Form-Factor Pluggable Transceiver (SFP) Types with Digital Diagnostic and Monitoring
- 1) Single Mode
    - a) 100Base-FX



- (1) 20km, 40km
    - (2) 1310nm
  - b) 1000Base-LX
    - (1) 10km, 20km, 40km; 1310nm
    - (2) 60km, 80km; 1550nm
- 2) Multimode
  - a) 100Base-FX
    - (1) 2km
    - (2) 1310nm
  - b) 1000Base-SX
    - (1) 550m, 850nm
    - (2) 2km, 1310nm
- 3) One Fiber Bidirectional
  - a) 1000Base-LX
    - (1) 40km; 1310nm/1550nm
    - (2) 60km; 1490nm/1550nm
- 4) Copper
  - a) 1000Base-T

## 2.02 TRAIN CONTROL MICROWAVE RADIO

- A. The Train Control Microwave Radio equipment shall be Aviat Eclipse IRU 600, Alcatel Lucent 9500 MPR, as indicated on the Drawings, or Engineer approved equivalent.
  - 1. Approved Equivalent Additional Requirements (At no additional cost)
    - a. Contractor shall provide a comprehensive Network Management System (NMS) for the equivalent equipment that meets or exceeds the existing NMS systems.
    - b. Contractor shall provide training for the equivalent equipment per Section 34 44 00 Part 1.13.

- c. Contractor shall provide a minimum of 2 spares of all equipment required for a microwave link.
- B. Microwave Indoor Baseband Unit equipment shall:
  1. Use native Ethernet connectivity and transport.
    - a. 802.1Q VLAN
    - b. 802.1p QoS
    - c. 802.3ad Link Aggregation
    - d. NTP time synchronization
  2. Support Bridge Protocol Data Unit (BPDU), RSTP, and path costs to eliminate Ethernet loops, while supporting path redundancy. It shall be possible to close Ethernet rings using alternate media such as fiber.
  3. Support ring/mesh reconvergence times of not more than 200ms.
  4. Support a 10/100/1000 redundant optical interface to the network switch.
  5. Support integrated Monitored Hot-Standby (MHSB) to ensure no single point of failure exists.
  6. Support multiple links on a common platform comprising of a baseband unit with one or more radio frequency units. Each link can be individually configured for frequency, capacity, traffic type and protection type.
  7. Support all indoor use.
  8. Support Ethernet link capacities of up to 380 Mbps.
  9. Support clock synchronization capability to align with a network master clock.
  10. Support Adaptive Coding and Modulation (ACM) steps of QPSK, 16 QAM, 64 QAM, and 256 QAM. Modulation switching shall be error-free.
  11. Support co-channel dual polarized (CCDP) link operation with cross channel interference cancellation (XPIC).
  12. Support Automatic Transmit Power Control (ATPC) for all frequency bands.
  13. Support link aggregation on two or more co-path Ethernet links using Layer 1 or Layer 2.
  14. Support interconnection of platforms to provide additional capacity at a site.
  15. Have NEBS level 3 compliance.

16. Support payload encryption.
  17. Support 3 levels of access
    - a. Administration (access authorization and password setting)
    - b. Engineering (read/write)
    - c. Operator (read only)
  18. Support operation from -48 VDC power supply and be 19-inch rack mountable.
  19. Support hot-swappable plug-in card to provide protection to the interface modules.
  20. Support a plug-in card for external alarms
    - a. Alarm outputs for internal alarm status via Form C relays
    - b. Alarm inputs for TTL interfaces. (2V high and 0.8V low)
    - c. Monitor transmission line dehydrator
    - d. Integrate alarms visibility with the NMS system.
- C. Microwave all Indoor Radio Unit (IRU) shall:
1. Be 1+1 optimized and include an Antenna Coupling Unit (ACU) to support paired and non-paired frequency assignments.
  2. Support the following licensed frequency bands:
    - a. 6 GHz (L6/U6)
    - b. 11 GHz
  3. Be of compact design and 19-inch rack mountable for collocation with its baseband unit.
  4. Have industry standard waveguide ports.
  5. Support stackable transceivers, with one installed for 1+0 operation and two for 1+1 or 2+0 operation.
  6. Support 1+0 repeater configurations.
  7. Support back-to-back 1+1 repeater configurations in conjunctions with a second collocated IRU.
  8. Have low power and high power RFU options. The high-power option shall use the best energy efficiency.

- D. Maintenance Software Requirements:
1. Shall support software version management for software upgrades.
  2. Shall support a craft tool to provide a means to source and save software upgrades and download software to the platform. Craft tool shall support the following options:
    - a. Transfer and activate new software.
    - b. Transfer only.
    - c. Activate transferred software.
    - d. Observe status of the download and activation process.
    - e. Ability to roll back to the prior build of the software.
    - f. Alarm status and event log access.
    - g. Select, view, and configure diagnostics on any platform within the network.
    - h. Set controls for loopbacks, AIS, protection locks, transmission mute and Bit Error Rate (BER) testing.
  3. Shall support a network management system.
    - a. The platform shall support SNMPv2 and MIB II tables.

**2.03 SECURITY DATA DENSE WAVELENGTH DIVISION MULTIPLEXING (DWDM) SWITCH**

- A. The Security Data Network (SDN) DWDM switch equipment shall be Ciena Service Delivery Switch (SDS) 3942, Ciena 5160 Service Aggregation Switch (SAS) as indicated on the Drawings, or Engineer approved equivalent.
1. Approved Equivalent Additional Requirements (At no additional cost)
    - a. Contractor shall provide a comprehensive Network Management System (NMS) for the equivalent equipment that meets or exceeds the existing NMS, OneControl.
    - b. Contractor shall provide training for the equivalent equipment per Section 34 44 00 Part 1.13.
    - c. Contractor shall provide a minimum of 4 spares of this equipment.
- B. SDN DWDM SDS switch shall:
1. Operate in a temperature range of -5 degrees C to +65 degrees C at climate-controlled Station or Facility locations.

2. Support 10 Gigabit Ethernet SFP/SFP+ ports. (4 minimum)
  3. Support 10/100/1000 Base TX copper ports. (20 minimum)
  4. Support the following transport options for CE 2.0 compliant MEF Ethernet Services:
    - a. G.8032 rings
    - b. 802.1Q VLANs
    - c. 802.1ad Provider Bridging
    - d. IP/MPLS
    - e. MPLS-TP
  5. Support redundant 120V AC or -48V DC power.
  6. Support Network Node Interface (NNI) and User Network Interface (UNI) connections via the SFP ports.
  7. Support 19-inch or 23-inch rack mount.
  8. Capable of Zero Touch Provisioning (ZTP) and will auto configure a new switch once connected to the network and powered up.
  9. Support built in service activation testing using RFC2544 and Y.1564.
  10. Support a remote management interface.
  11. Support a quick reset (reboot) and a hard reset (factory defaults).
  12. Support the following Operations, Administration and Maintenance (OAM) features:
    - a. 802.1ag Connectivity Fault Management (CFM) with hardware assisted performance.
    - b. 802.3ah Ethernet in the First Mile (EFM)
    - c. 802.1AB Link Layer Discovery Protocol (LLDP)
    - d. Y.1731 performance monitoring for delay, jitter and loss with hardware assisted performance.
    - e. MPLS/MPLS-TP OAM suite (LSP ping, traceroute)
- C. SDN DWDM SAS switch shall:
1. Operate in a temperature range of -40 degrees C to +65 degrees C at climate-controlled Station or Facility locations.

2. Support 1 Gigabit Ethernet / 10 Gigabit Ethernet SFP+ ports. (24 minimum)
3. Support the following transport options for CE 2.0 compliant MEF Ethernet Services:
  - a. G.8032 rings
  - b. 802.1Q VLANs
  - c. 802.1ad Provider Bridging
  - d. IP/MPLS
  - e. MPLS-TP
  - f. Provider Backbone Bridge Traffic Engineering (PBB-TE)
4. Support redundant 120V AC, +24V DC, or -48V DC power.
5. Support Network Node Interface (NNI) and User Network Interface (UNI) connections via the SFP ports.
6. Support 19-inch or 23-inch rack mount.
7. Capable of Zero Touch Provisioning (ZTP) and will auto configure a new switch once connected to the network and powered up.
8. Support built in service activation testing using RFC2544 and Y.1564.
9. Support a remote management interface.
10. Support a quick reset (reboot) and a hard reset (factory defaults).
11. Support the following Operations, Administration and Maintenance (OAM) features:
  - a. 802.1ag Connectivity Fault Management (CFM) with hardware assisted performance.
  - b. 802.3ah Ethernet in the First Mile (EFM)
  - c. 802.1AB Link Layer Discovery Protocol (LLDP)
  - d. Y.1731 performance monitoring for delay, jitter and loss with hardware assisted performance.
12. Synchronization and Timing
  - a. Supports G.8262 Synchronous Ethernet for frequency distribution and reference.

- b. Supports 1588v2 Precision Time Protocol (PTP), including Ordinary Clock and Boundary Clock support for frequency, phase, and time distribution.
- c. Supports dedicated external ports for local frequency, phase, and time references.

## 2.04 GIGABIT LTE CELLULAR

- A. The Gigabit LTE Cellular equipment shall be Cradlepoint IBR900-1200M-B as indicated on the Drawings, or Engineer approved equivalent.
  1. Approved Equivalent Additional Requirements (At no additional cost)
    - a. Contractor shall provide a comprehensive Network Management System (NMS) for the equivalent equipment that meets or exceeds the existing NMS.
    - b. Contractor shall provide training for the equivalent equipment per Section 34 44 00 Part 1.13.
    - c. Contractor shall provide a minimum of 4 spares of this equipment.
- B. The Gigabit LTE Cellular equipment shall:
  1. Support AT&T and Verizon
  2. Be FirstNet Ready
  3. Have a throughput of 940 Mbps
  4. Support 802.11ac Wave 2 (Wi-Fi 5)
  5. Operate in a temperature range of -30 degrees C to +70 degrees C.
  6. Be ruggedized for vibration, shock, dust, splash and humidity.
  7. Support GPS.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. General
  1. Visually inspect all equipment for possible damage upon receipt and prior to installation. Do not install any damaged equipment.
  2. All equipment shall be installed in accordance with the manufacturer's recommendations.

3. All equipment chassis shall be grounded to the main ground within the enclosure. Use a separate ground cable for each equipment instance. If equipment is grounded to the rack, verify that the rack is connected to the main ground. Do not assume that an existing rack is correctly grounded.
  4. Mount equipment with clearance to allow for proper ventilation and air flow.
  5. Route interface cables carefully to ensure cable bend radius is maintained throughout the installation.
  6. If intra enclosure cabling is required, shielded and grounded cables shall be used. Cables shall be grounded at both ends.
- B. Train Control Ethernet Switch
1. All slots shall be filled with a module or a blanking panel.
- C. Train Control Microwave Radio
1. Enter the factory measured insertion loss data labeled on the ACU.
  2. The ACU shall be retuned if the frequency is changed outside its specified pass band. ACUs shall be returned to the manufacturer for retuning.
  3. Do not route interface cabling with any AC main power line.
  4. For NEBS compliance, the fan air filter and power line filters shall be installed.
  5. All slots shall be filled with a plug-in or a blanking panel.
  6. Never disconnect or reconnect an IRU without first turning power off.
- D. Security Data DWDM Switch
1. Ensure that the installed SFP optic matches the capability of the port and that the SFP optic is supported by the system.
  2. All unused SFP ports shall contain dust covers.
  3. For the DC power connections, use the manufacturer recommended fork terminal spade lugs.
- E. Gigabit LTE Cellular
1. Prior to installation, confirm the device has the latest version of firmware that supports the device.
  2. Mount the device out of reach. The surface of the device may become too hot to safely touch.



3. The SIM card shall be provisioned by the cellular carrier SCRRA has selected for each location.
  4. Connect the power adapter to the nearest AC receptacle.
  5. Adjust antenna to optimize signal strength as indicated on the equipment.
- F. Testing
1. All Ethernet networks:
    - a. Verification of transmission between copper ports with a maximum throughput (99% packet transmission or better) for a minimum test duration of two minutes. (SCRRA network paths only)
    - b. Verify and record failover time during a protective switch by disabling the SFP transmitter via software during maximum throughput transmission for a link.
  2. Microwave
    - a. Bit Error Rate (BER) test shall be performed for each link for a minimum time of 24 hours.
    - b. Record failover time during a protective switch.
  3. Optical Ethernet
    - a. Verification of 6dB link margin with maximum throughput (99% packet transmission or better) across each optical link for a minimum test duration of five minutes.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Wide Area Network 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. Wide Area Network 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 34 44 70**

**SECTION 34 44 95**  
**DATA RADIO NETWORK**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. The work in this Section describes the technical requirements for products and supporting components to be furnished, installed and tested to support, extend or modify the Data Radio Network.
- B. Requirements for various Radio technologies deployed and utilized by SCRRA including ATCS Radio and Ethernet Radio are detailed herein. The Pomona DOC is the SCRRA Operations Center.
- C. ATCS radio is a secondary redundant method for transport of Centralized Traffic Control (CTC) information to the DOC. SCRRA, along with the industry, is presently migrating away from ATCS radio for CTC communications to using the PTC radio and spectrum. In the interim, Contractor shall continue to deploy ATCS at Control Points unless otherwise directed by SCRRA.

**1.02 RELATED SECTIONS**

- A. Related Specification Sections include but are not limited to:
  - 1. 34 42 60 Miscellaneous Materials
  - 2. 34 44 00 Railroad Communications Requirements
  - 3. 34 44 05 Communications Basic Equipment Materials and Methods
  - 4. 34 44 10 Prefabricated Communications Shelter
  - 5. 34 44 20 Communications Wire and Cable
  - 6. 34 44 70 Wide Area Network

**1.03 REFERENCES**

- A. AAR ATCS Specification 200
- B. FCC 15.107 – Conducted Emissions Including AC Line
- C. FCC 15.109 – Unintentional Radiated Emission Limits
- D. FCC 15.205 – Restricted Bands of Operation
- E. FCC 15.207 – Conducted Emissions From Intentional Radiators

- F. FCC 15.209 – Radiated Emission Limits, General Requirements
- G. FCC 15.247 – ISM Band Communications Equipment
- H. FCC 90.210 – Emission Masks
- I. FCC 101.101 – Frequency Availability
- J. IEC International Protection Code - IP66 Protection
- K. IEEE 802.3af – Power over Ethernet (PoE)
- L. TIA-603 – Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

#### **1.04 SUBMITTALS**

- A. Submit cut sheets for all proposed products that meet the specifications of this Section.
- B. Submit operation, installation, engineering and maintenance manuals for all equipment furnished.
- C. The Plans have been prepared using Vendor specific equipment. Should the Contractor propose equivalent systems and they are approved by the Engineer, the Contractor shall update all Plans where the equipment is used at no additional cost.
- D. ATCS Base Station
  - 1. Submit simulated Predicted Area of Coverage and Line of Sight plots for each Control Point from the 2 closest ATCS bases to establish the expected test results.
  - 2. Submit final commissioned configuration files (Code-Plug) for all locations, base and wayside.
- E. Ethernet Radio
  - 1. Submit Line of Sight survey for each new link.
  - 2. Submit simulated Line of Sight plots showing the link budget for each link shown in the Drawings.
  - 3. Submit final commissioned configuration files for all locations.

### **PART 2 - PRODUCTS**

#### **2.01 ATCS BASE STATION**

- A. ATCS Base Radio

1. The ATCS Base Station Radio shall be Motorola MOTOTRBO MTR3000 or Engineer approved equivalent.
  - a. Approved Equivalent Additional Requirements (At no additional cost)
    - 1) Contractor shall provide a comprehensive Network Management System (NMS) for the equivalent equipment that meets or exceeds the existing NMS, WCCMaint.
    - 2) Contractor shall provide training for the equivalent equipment per Section 34 44 00 Part 1.13.
    - 3) Contractor shall provide a minimum of 2 spares of this equipment.
  - b. ATCS Base Station Radio shall:
    - 1) Support the following UHF frequency pairs:
      - a) Base Station Tx, 935.9875 MHz
      - b) Control Point Tx, 896.9875 MHz
    - 2) Support the following operating temperatures:
      - a) -30 degrees C to +60 degrees C
    - 3) Be capable of continuous duty cycle operation with a power output from 8W to 100W.
    - 4) Be capable of electronic adjustments to output power and deviation.
    - 5) Be capable of 12.5kHz channel spacing and a maximum deviation of +/- 2.5kHz.
    - 6) Have 4FSK and FM data modulation.
    - 7) Have Spurious and Harmonic Emissions Attenuation of 90dB
    - 8) Have FM Hum and Noise of 50dB
    - 9) Have Audio Response of +1, -3dB from 6dB per octave pre-emphasis
    - 10) Have Frequency Stability of 1.5 PPM
    - 11) Be powered by 24VDC.
    - 12) Have Analog Sensitivity (12dB SINAD) of 0.30uV

- 13) Have Intermodulation Rejection of 85dB
- 14) Have Spurious and Image Response Rejection of 85dB
- 15) Have Selectivity (TIA603) of 75dB
- 16) Be capable of 19-inch rack mount.

B. ATCS Base Control Module

1. The ATCS Base Control Module shall be Siemens 9000-53444-0001 or Engineer approved equivalent.
  - a. ATCS Base Control Module shall:
    - 1) Operate input voltage of 24VDC
    - 2) Provide the interface between the ATCS RF network and the Office Communications Gateway (OCG) located at the DOC.
    - 3) Be 19-inch rack mountable.
    - 4) Provide 8 opto-isolated input connections and 2 opto-isolated output connections.
    - 5) Store the site configuration file. (code plug)
    - 6) Contain boot code with a system self-test upon power up or reset.
    - 7) Have a debugger to provide low level diagnostics and direct access to hardware and firmware for testing purposes.
      - a) Event log
      - b) Log Capture

C. ATCS Base RF Duplexer

1. The ATCS Base RF Duplexer shall be Sinclair Q4220E-2 or Engineer approved equivalent.
  - a. ATCS Base RF Duplexer shall:
    - 1) Enable simultaneous transmission and reception of ATCS messages.
    - 2) Be 19-inch rack mountable.
    - 3) Support the following operating temperatures:

- a) -40 degrees C to +60 degrees C
  - 4) Have 2 Tx cavities and 2 Rx cavities
  - 5) Have an Input VSWR of 1.5:1
  - 6) Use N-Female connectors
  - 7) Have an Insertion Loss maximum of 1dB
  - 8) Provide minimum Isolation of 80dB
  - 9) Have 50-ohm Impedance
- D. ATCS Communications Network Adapter
1. The ATCS Communications Network Adapter shall be Wabtec CNA2004 or Engineer approved equivalent.
    - a. ATCS Communications Network Adapter shall:
      - 1) Enable the primary data communications connection to the Control Point to support an Ethernet 10/100 Base-T LAN connection.
      - 2) Enable a secondary data communications connection to the Control Point through the ATCS RF network.
      - 3) Manage the normal/stand-by route connections between primary Ethernet and ATCS RF.
      - 4) Provide the physical interface and protocol conversion for the ATCS/UDP/IP socket connection.
      - 5) Be integrated into the ATCS network management system.

## 2.02 ETHERNET RADIO

- A. The Train Control Ethernet Radio equipment shall be Afar AR-9010E or Engineer approved equivalent.
1. Approved Equivalent Additional Requirements (At no additional cost)
    - a. Contractor shall provide a comprehensive Network Management System (NMS) for the equivalent equipment that meets or exceeds the existing NMS system.
    - b. Contractor shall provide training for the equivalent equipment per Section 34 44 00 Part 1.13.

- c. Contractor shall provide a minimum of 2 sets of all equipment required for an Ethernet radio link, consisting of 1 access point and 2 subscribers.
- B. Ethernet Radio equipment shall:
  1. Use Direct Sequence Spread Spectrum and operate in the unlicensed ISM band at 900MHz.
  2. Support a maximum data rate of 1.1 Mbps.
  3. Support an occupied bandwidth of 1.7 MHz.
  4. Support the following topologies:
    - a. Point to Point
    - b. Point to Multipoint
  5. Support remote management via:
    - a. Telnet
    - b. SNMP
  6. Support the following encryption algorithms:
    - a. DES
    - b. Triple-DES
    - c. AES-128
    - d. ASE-256
  7. Utilize PoE 802.3af for the source of power.
  8. Utilize separate transmit and receive frequencies.
  9. Incorporate spectrum analysis and timing analysis tools to survey the RF environment.
  10. Provide an antenna alignment aid providing audio feedback proportional to the RSSI.
  11. Route packets to reduce the minimum number of hops through a learning algorithm.
  12. Utilize N-female connectors for antenna connections.
  13. Be housed in an IP-66 weatherproof enclosure.



## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

#### **A. General**

1. Visually inspect all equipment for possible damage upon receipt and prior to installation. Do not install any damaged equipment.
2. All equipment shall be installed in accordance with the manufacturer's recommendations.
3. All equipment chassis shall be grounded to the main ground within the enclosure. Use a separate ground cable for each equipment instance. If equipment is grounded to the rack, verify that the rack is connected to the main ground. Do not assume that an existing rack is correctly grounded.
4. Mount equipment with clearance to allow for proper ventilation and air flow.
5. Route interface cables carefully to ensure cable bend radius is maintained throughout the installation.

#### **B. ATCS Base Station**

1. All transmission lines shall be grounded with coax grounding kits at the top of the tower near the antenna, at the bottom of the tower and prior to coax entry into the shelter.
2. A surge arrestor such as a Polyphaser shall be placed in line with the transmission line after it enters the shelter and the radio equipment.
3. The transmit and receive antenna RF connections shall be made using two separate N-type connectors.
4. Upon power up, view the front bezel LEDs for the general status and condition of the radio.
5. Base stations shall use Type 3 addressing.
6. Wayside equipment shall use Type 7 addressing.

#### **C. Ethernet Radio**

1. Verify that line of sight exists for each link. Report any obstructions to the Engineer.
2. Perform an initial check of the radio using 2 units before field installation. This will confirm the radios are working properly so other factors (RSSI, interference) can be addressed in the field.
3. Select the appropriate bracket for pole mounting or on a flat surface.

4. Ground the radio enclosure to Earth ground nearest the structure to minimize static buildup or lightning damage. Ground wire shall be a straight connection with no loops. Do not bundle the grounding cable with any other cable used for data, power or RF.
5. Use anti oxidizing paste to apply to the ground lug blade, exposed cable, grounding point surface, as well as the thread of the screw to secure the lug.
6. Install a surge suppressor module at the point where the CAT5E cable enters the enclosure to protect equipment against surges.
7. Do not exceed the CAT5E cable length as recommended by the manufacturer. Use the radio software to measure the voltage at Port D to validate a minimum voltage of 9.5 VDC.
8. Mounted antennas shall have the same polarization and directional antennas shall be pointed to each other to maximize the RSSI. Ground the antenna and verify the mast or tower is Earth grounded.
9. Weatherproof all external cable connections. Coax seal completely covered by all weather electrical tape.
10. Use audible RSSI to align the antenna.
11. Configure the access radio with a WAN connection to the be hub. The subscriber radios will automatically join the network.
12. Directional antennas may need to be used if there is interference from other equipment. Use the radio to perform a spectrum analysis.
13. Do not exceed the Maximum Output Power required by the FCC as follows:
  - a. 5 dBi Antenna – 27 dBm
  - b. 15 dBi Antenna – 19 dBm
14. Once the deployment is complete, record the configuration of each radio installed.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Data Radio Network 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. Data Radio Network 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 34 44 95**

## SECTION 34 71 50

### HIGHWAY-RAIL GRADE CROSSINGS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Constructing new highway-rail grade crossings of SCRRRA railroad tracks.
  - 2. Removing and reconstructing existing highway-rail grade crossings.
- 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 43 – Electric: Exterior Underground.
  - 4. Section 33 42 00 – Culvert and Drainage Pipe.
  - 1. Section 32 12 00 – Hot Mix Asphalt Pavement
  - 2. Section 34 11 10 – Continuous Welded Rail (CWR).
  - 3. Section 34 11 23 - Other Track Materials (OTM).
  - 4. Section 34 11 16 – Ballast.
  - 5. Section 34 11 34 – Wood Railroad Tie
  - 6. Section 34 11 40 – Precast Concrete Grade Crossing Panels
  - 7. Section 34 72 00 - Trackwork.
  - 8. Section 34 72 20 – Track Shifting, Relocation and Resurfacing.
  - 9. Section 34 72 30 – Field Welding Rail.
  - 10. Section 34 80 43 – Precast and Prestressed Concrete for Railroad Bridges.

##### 1.02 REFERENCES

- A. SCRRRA: Engineering Standards, and SCRRRA Track Maintenance Manual.
- B. ASTM International (ASTM):

1. D3776 Standard Test Methods for Mass per Unit Area (Weight) of Fabric.
  2. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
  3. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
- C. SSPWC: Latest Edition, Standard Specifications for Public Works Construction, "Greenbook", Public Works Standards, Inc.
- D. California Public Utilities Commission (CPUC): General Order(s) for road crossing(s) being newly constructed, removed or reset under the Project.
- E. State of California Department of Transportation: California Manual on Uniform Traffic Control Devices (CA MUTCD), Latest Edition.
- F. WATCH: Work Area Traffic Control Handbook, Latest Edition, WATCH BOOK, APWA Southern California Chapter.
- G. Federal Railroad Administration (FRA): 49 CFR Part 213, Track Safety Standards.
- H. Americans with Disabilities Act (ADA).
- I. Materials not meeting the requirements of this Specification shall not be used in the Work.

### **1.03 SUBMITTALS**

- A. General
1. Submittals shall be made in accordance with Division 01 requirements.
- B. Plans and Procedures:
1. Traffic Detour Plan signed by a Registered Professional Engineer using SCRRA Design Criteria Manual Chapter 29, Temporary Traffic Control, SCRRA Engineering Standards ES4301, and incorporating provisions of the State of California MUTCD and the WATCH BOOK.
  2. Site Specific Work Plan (SSWP) and Operating System Interface in accordance with Division 01 requirements.
- C. Certificates:
1. Material Test Reports for products purchased and used in the Project.
- D. Product Data and Shop Drawings:
1. Product technical data including:

- a. Acknowledgement that products submitted meet requirements of standards referenced.
  - b. Manufacturer's installation instructions.
  - c. Shop Drawings detailing dimensions, reinforcement and lifting apparatus for precast crossing panels.
    - 1) Precast concrete mix design in accordance with Section 34 80 43.
    - 2) Structural calculations.
    - 3) Manufacturing and curing procedures.
- E. Miscellaneous Submittals:
1. Submit quality control test results for testing performed for precast concrete panels and other material. Testing shall be performed by a certified test laboratory hired by the Contactor or fabricator and approved by the Engineer.
  2. Verification documentation that Contractor requested DigAlert field location of underground utilities and SCRRRA clearance of underground railroad utilities prior to starting any excavation work in accordance with Division 01 requirements and Section 6, Utilities, of SCRRRA Form 37, Rules and Requirements for Construction on SCRRRA Right-of-Way.
  3. Contractor must submit qualifications and experience of installers of precast concrete grade crossings.

#### **1.04 QUALITY ASSURANCE**

- A. Employ a skilled foreman for the Installation of grade crossings, having no less than 3 years experience in installation of the type of grade crossing panels used.
- B. Track work shall be performed under the supervision of an FRA Part 213 Track Safety Qualified Foreman in accordance with requirements of Section 34 72 00.
- C. The Engineer, will review test reports in accordance with the Specifications as applicable for the material item and may require additional testing to confirm requirements with the Specifications.

#### **1.05 PROJECT SITE CONDITIONS**

- A. Prior to commencing Work, Contractor must examine the Contract Documents, inspect the site, obtain and review available Record Drawings of existing work and utilities and note conditions and limitations which may influence work required by this Section in accordance with Division 01 requirements.

- B. Contractor must execute Work under this Specification in such a manner as to minimize impact to the daily operation of the railroad, vehicular and pedestrian traffic in accordance with Division 01 requirements and the approved Traffic Control Plans.
- C. Contractor must maintain vehicular traffic and pedestrian walkways using barricades, warning signs and warning lights in accordance with Division 01 requirements.
  - 1. Warning lights shall be set so they do not shine into the eyes of locomotive engineers in on-coming trains.
  - 2. Temporary pedestrian walkways shall meet ADA standards.

## **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 (SWPPP) 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 in accordance with Division 01 requirements.
- C. Contractor must provide for site cleanliness, sweeping and dust control 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 any required excavation drawings or traffic control plans to Engineer for review and approval by SCRRRA and jurisdictional authorities.
  - 1. Contractor to obtain permits for performing such work as required in accordance with Division 01 requirements.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

- A. Precast Concrete highway-rail grade crossing Panels shall be new and conform to Section 34 11 40:
- B. Wood Ties: Ties shall be new 10 feet long and conform to Section 34 11 34.
- C. Ballast: Ballast shall be new and conform to Section 34 11 26.
- D. Rail: Rail size shall be 136# CWR and shall conform to Section 34 72 00.

E. Rail Fastening: Rail fastenings shall be new and shall conform to Section 34 72 00.

F. Geotextile:

1. Geotextile filter fabric used for grade crossings shall be nonwoven fabric. The filaments shall be polypropylene, polyester, or polyethylene. The filaments must be dimensionally stable (i.e., filaments must maintain their relative position with respect to each other) and resistant to delaminating. The filaments must be free from any chemical treatment or coating that might significantly reduce porosity and permeability. Nonwoven fabric may be needle-punched, heat-bonded, resin-bonded, or combinations thereof.
2. The physical properties for Geotextile shall conform to the following:

Test Method	Property	Requirement
ASTM D3776	Minimum Weight (oz./sq. yd.)	3.5
ASTM D4632	Minimum Wet Grab Tensile Strength (lbs.)	100
ASTM D4632	Minimum Grab Elongation at Break (%)	20
ASTM D4751	Apparent Opening Size(US Sieve)	30

G. Asphalt Concrete:

1. Asphalt concrete for crossing underlayment shall conform to Section 34 80 33, HMA for Bridges.
2. Asphalt concrete for roadway shall conform to Section 32 12 00, Hot Mix Asphalt Concrete. Asphalt concrete for roadway approach paving shall conform to Section 32 12 00, Hot-Mix Asphalt Concrete and the Greenbook Section 203 – Bituminous Materials as noted in SCRRA Engineering Standards ES4201 for permanent crossings or ES4302 for temporary crossings or Agency requirements as specified in the Plans or Project Special Provisions.
  - a. Contractor must submit the proposed pavement design to the Engineer for review and acceptance. Roadway approach paving will be reviewed and accepted by SCRRA and the local agency governing the crossing.

H. Cast-in-Place Concrete

1. Cast-in-Place concrete for new or replacement sidewalks, curbs, gutters and other concrete items shall conform to Section 03 31 00 or as shown in the Plans.



- a. Minimum 28-day compressive strength shall be 3250 psi (560-C-3250 –SSPWC) unless otherwise shown in the Plans.
- I. Perforated Drain Pipe:
  1. Perforated drain pipe shall be Schedule 80 PVC pipe in accordance with Section 33 46 00.
- J. Signal Conduit:
  1. Signal conduits shall be Schedule 80 PVC electrical conduit in accordance with Section 34 42 00.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Coordinate with SCRRA Signal Department forces in accordance with Division 01 requirements.
- B. Demolish and dispose of existing grade crossing material including asphalt concrete pavement, sidewalks, curbs and gutters and other items as required in the Plans in accordance with Section 31 11 50.
- C. Remove and salvage existing grade crossing panels or other crossing appliances as required in the Plans in accordance with Section 31 11 50.
- D. Track subgrade, asphalt underlayment, and ballast shall be constructed to extend at each end, beyond the limits shown for each grade crossing in accordance with SCRRA Engineering Standards ES4201 or as shown in the Plans, whichever is greater.

### **3.02 SUBGRADE AND SITE PREPARATION**

- A. Prepare subgrade in accordance with the Contract Documents, Section 31 20 00 and SCRRA Engineering Standards ES4201.
- B. Remove existing concrete foundations, curbs, sidewalks, storm drains, pavement and traffic striping as shown in the plans in conformance with Section 31 11 50.
- C. Cut lines for asphalt and concrete shall be straight and neat in accordance with Section 31 11 50 and any damage to facilities to remain shall be repaired to the approval of the Engineer at no additional cost to SCRRA.

### **3.03 DRAINAGE AND SUBDRAINAGE**

- A. Drainage and subdrainage work including placement of geotextile wrap of perforated drainage pipe, shall be performed as specified in the Contract Documents and in accordance with SCRRA Standard Plans ES4201.

**3.04 HOT MIX ASPHALT (HMA) CROSSING UNDERLAYMENT**

- A. Hot Mix Asphalt (HMA) pavement for crossing underlayment shall be placed as indicated in the Contract Documents, according to Section 32 12 00 and as shown in SCRRA Engineering Standards ES4201.
- B. Hot Mix Asphalt (HMA) pavement end ramps shall be provided at all concrete grade crossing panel installations in accordance with SCRRA Engineering Standards ES4201 if the preapproved crossing panel is used. End ramps shall be per the manufacturer's recommendation if a substitute is approved, but shall not be less than 3 feet in length.

**3.05 SIDEWALKS, CURBS, GUTTERS AND OTHER ROADWAY ITEMS**

- A. Place new sidewalks, curbs, gutters and other roadway items as shown in the Contract Documents, including the identified standards of the public agency identified in the Contract Documents responsible for the roadway and SCRRA Engineering Standards ES4001 through ES4021.
- B. Highway-Railroad Grade Crossing Crossbuck signs, when called for, shall be installed in accordance with SCRRA Standard Drawing ES4310.
- C. Private, Pedestrian and Bicycle Railroad Grade Crossing Sign, when called for, shall be installed in accordance with SCRRA Engineering Standards ES4311.
- D. Temporary construction crossing signs, when called for, shall be installed in accordance with SCRRA Engineering Standards ES4302.

**3.06 PRECAST CONCRETE HIGHWAY-RAIL GRADE CROSSING PANELS**

- A. Install precast concrete grade crossing panels to the position and location shown in the Contract Documents in accordance with manufacturer's recommendations, the approved procedures and SCRRA Engineering Standards ES4201.
  - 1. Contractor must use SCRRA Engineering Standards ES4201 when using the preapproved crossing panel.
- B. Contractor must clean dirt and debris from the flangeways before releasing the crossing for the passage of trains.

**3.07 BALLAST**

- A. Place and spread ballast in accordance with the details indicated on the Contract Documents, SCRRA Engineering Standards ES4201 and Section 34 72 00.

**3.08 TIES**

- A. Grade crossing ties shall be spaced per crossing manufacturer's recommendations, and spacing per SCRRRA Engineering Standards ES4201. Other tie location and layout distances shall be per the SCRRRA Engineering Standards ES4201.
- B. Tops of all ties within the crossing limits shall lie in the same plane. Any tie with an irregular surface dimension shall be adzed or replaced.

**3.09 HIGHWAY-RAIL GRADE CROSSING TRACK CONSTRUCTION**

- A. Construction and fastening of track through grade crossings shall be performed in accordance with details shown on the Contract Documents, SCRRRA Engineering Standards ES4201 and Section 34 72 00.
- B. Rail joints or thermite welds are not permitted within the limits of the grade crossing trackwork unless approved by the Engineer.
- C. Rail joints consisting of field welds are permitted at the ends of rail strings placed for crossings. Welds shall conform to Section 34 72 30.
- D. Contractor must use a dynamic stabilizer after initial tamping and surfacing followed by a second surfacing pass in accordance with Section 34 72 20, prior to the final installation of the grade crossing panels.
- E. Every attempt needs to be made to close the roadway for the crossing construction so that the entire crossing can be completed continuously. If the roadway cannot be closed, extra efforts shall be utilized to ensure track surface profile is maintained during and after construction, including but not limited to an extra dynamic stabilizer pass.

**3.10 FIELD QUALITY CONTROL/QUALITY ASSURANCE**

- A. Compaction testing for subgrade, trench backfill and sub-ballast shall conform to Section 31 20 00.
- B. Compaction testing for asphalt concrete crossing underlayment shall conform to Section 34 80 33.
- C. Contractor must coordinate with and provide 24 hours advance notice of crossing work to SCRRRA Signal Inspectors and verify that testing of all crossing signal work has been completed and accepted by SCRRRA prior to opening crossing to vehicular traffic.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

- A. Highway-rail grade crossings 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 34 11 10, Continuous Welded Rail (CWR); 34 11 15, Other Track Materials (OTM); 34 11 16, Ballast; 34 11 27, Sub-Ballast and Aggregate Base; 34 11 34, Wood Railroad Ties; 34 11 36, Elastic Rail Fasteners; and 34 11 40, Precast Concrete Grade Crossing Panels 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.
- C. No separate measurement and payment will be made to the Contractor for removal of concrete panels.

**4.02 PAYMENT**

- A. Highway-rail grade crossings 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 furnishing all labor, materials, tools, equipment, fees, supplies, supervision, and incidentals within the limits of highway-rail grade crossing work in accordance with SCRRRA Engineering Standards ES4201 necessary for any highway-rail grade crossings described by the Contract Documents.

**END OF SECTION 34 71 50**

## **SECTION 34 72 00**

### **TRACKWORK**

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

##### **1.01 SUMMARY**

- A. This Section consists of the Contractor, unless otherwise indicated, furnishing all labor, materials, equipment, tools, and incidentals necessary to remove, repair, modify, rehabilitate, or construct trackwork, turnouts, crossings and crossovers.
  - 1. Work includes ballast, walkways, ties, rail, fastening systems, other track material (OTM), turnouts and other special trackwork.
  
- 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 34 11 10 – Continuous Welded Rail (CWR).
  - 4. Section 34 11 15 - Other Track Materials (OTM).
  - 5. Section 34 11 23 – Special Trackwork.
  - 6. Section 34 11 16 - Ballast.
  - 7. Section 34 11 27 - Sub-Ballast and Aggregate Base.
  - 8. Section 34 11 33 - Concrete Railroad Ties.
  - 9. Section 34 11 34 - Wood Railroad Tie.
  - 10. Section 34 71 50 – Highway-Rail Grade Crossings.
  - 11. Section 34 72 30 – Field Welding Rail.

##### **1.02 REFERENCES**

- A. American Railroad Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering.
  
- B. FRA: 49 CFR Part 213, Track Safety Standards, most current and addenda, Federal Railroad Administration.
  
- C. SCRRRA: Engineering Standards.

- D. SCRRA: Current SCRRA Track Maintenance Manual.
- E. SCRRA: Design Criteria Manual.

### 1.03 SUBMITTALS

- A. Submit, under the provisions of Division 01:
  - 1. Materials: Submit individual certifications that all materials furnished by the Contractor conform to the specified requirements.
  - 2. Shop Drawings:
    - a. Submit Shop Drawing and product data for trackwork items not specifically defined by engineering standards.
    - b. Shop Drawings for each size and direction of Turnout will be required.
    - c. Shop Drawings shall also be submitted in electronic media Microstation V8i (or latest) format on removable media (compact discs or DVD, or USB drives) and shall conform to SCRRA's CADD Manual.
  - 3. Equipment: Provide submittal for all construction equipment proposed to be used as identified in Division 01.
  - 4. Procedure: Submit procedure for transporting, stockpiling and handling of trackwork Materials.
    - a. Submit proposed construction and installation procedure for new trackwork as part of the Site-Specific Work Plan (SSWP) submitted under Division 01, Coordination with SCRRA.
    - b. Contractor may modify Installation procedure stated hereinafter, to produce the most efficient method for track construction, subject to approval by the Engineer.
  - 5. Compliance Record: As-built compilation of actual track geometry produced in construction including curvature, length of reversing tangent, length of spirals, top of rail profile, and super elevation values.
  - 6. Compliance Record: Rail temperature record taken during anchorage and de-stressing procedures as described in the Articles entitled "Procedures for Placement of CWR" and "Anchoring CWR" herein.
  - 7. Compliance Record: Test results for insulated joints as described in Article entitled "Insulated Joints" in Part 3 of this Section.
  - 8. Procedure: Quality Control / Quality Assurance Program.
  - 9. Procedure: Submit rail end hardening procedure.

10. Procedure: Submit procedure and field welding material technical data for field welding rail.
11. Procedure: De-stressing of Rail.
12. Procedure: Installation of insulated joints.
13. Procedure: Plan for the coordinating and scheduling of a signal track support crew to protect and maintain the operating signal system.

#### **1.04 QUALITY ASSURANCE**

##### **A. Quality Assurance:**

1. Perform track construction under the supervision of Qualified personnel, as defined in Division 01.
2. Corrections by Contractor: During the Installation and testing period, Contractor must make available personnel, equipment, and Materials necessary to make required corrections to the track including such work as replacements, re-ballasting, resurfacing and realigning, or repair of constructed items, as the Engineer may require ensuring completion of the Work in accordance with the Contract.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- ##### **A. Ties shall be lifted and supported during storage, transportation, and placing in such a manner as to prevent damage.**
1. Ties shall not be dropped to the roadbed.
  2. Wood ties shall be handled in accordance with AREMA Manual Volume 1, Chapter 30, Section 3.5 and Concrete Ties shall be handled in accordance with AREMA Manual Volume 1, Chapter 30, Section 4.11.
  3. Refer to Sections 34 11 34 and Section 34 11 33 for on-site storage requirements.
- ##### **B. Rail shall be unloaded and distributed in a manner that prevents damage to ties, rails and structures. Do not bump or strike rail.**

### **PART 2 - PRODUCTS**

#### **2.01 CONSTRUCTION EQUIPMENT**

- ##### **A. If the Engineer determines that Contractor's equipment is not in good working condition or that the kind, size, capacity or quantity of equipment is incapable of contributing to the Work progress or to the requirements of the Contract Documents, Contractor must promptly replace the equipment with an improved kind, type, size, capacity, or quantity. Rejection of equipment shall not be considered justification for a delay Claim.**

- B. Track surfacing and alignment equipment shall be laser guided.
  - 1. Track surfacing equipment must have all tamping tools in good repair and working order.
  - 2. As a minimum at least 70 percent of the original surface area of the tamping tool pad must be available and these tools must closely match adjacent and opposite tamping tool pads in the amount of wear.
- C. Equipment shall be compatible with and shall be operated within the clearances indicated in SCRRRA Engineering Standards.
- D. Wheel contours of all rail-mounted equipment shall conform to the Association of American Railroads (AAR) wheel standards or AREMA maintenance of way equipment wheel standards.
- E. All construction loads borne by equipment shall be applied between gage lines of running rails on each track unless approved by the Engineer.
- F. Vibratory compaction equipment for compaction of base ballast shall be specifically manufactured for compaction purposes.
  - 1. The self-propelled, pneumatic-tired roller shall have a gross weight of 10 to 15 tons, and the vibratory compactor shall have a weight of not less than 10 tons and shall be capable of applying a dynamic load of not less than 18,000 lbs. at 1300 to 1500 cycles per minute.
  - 2. The proposed compaction equipment is subject to approval by the Engineer.
- G. Ballast Stabilizer for compacting ballast in crib and shoulder areas shall be approved by the Engineer.

## 2.02 TRACK TOOLS

- A. Furnish tools and equipment necessary to construct the track.
- B. Track gages, track levels, and other tools shall conform to the AREMA Volume 1, Chapter 5, Part 6, "Specifications and Plans for Tools."
- C. Tools and equipment shall be maintained in such a condition as not to endanger personnel nor damage the Work and shall be subject to inspection by the Engineer.
- D. Tools not conforming to standard shall be repaired to AREMA standards or shall be replaced.
  - 1. Substitution of tools other than AREMA standard will be permitted only with approval of the Engineer.



- E. Track levels and gages shall be checked for accuracy at the start of every work shift and at any time the tool is dropped or struck.
  - 1. Adjustments shall be performed anytime it is found to have more than 0.050 inches deviation from the nominal measurement value.

### **2.03 SUB-BALLAST**

- A. Sub-Ballast shall conform to the requirements of Section 34 11 27.

### **2.04 BALLAST AND WALKWAY ROCK**

- A. Ballast shall conform to the requirements of Section 34 11 16.
- B. Walkway rock shall conform to the requirements of Section 34 11 26.

### **2.05 TIES**

- A. Wood ties shall conform to the requirements of Section 34 11 34.
  - 1. Cross ties and switch ties shall be of the lengths detailed on the Contract Documents or the designated SCRRA Engineering Standard.
  - 2. Ties shall be new unless indicated otherwise in the Contract Documents.
- B. Concrete ties shall conform to the requirements of Section 34 11 33 and SCRRA Engineering Standard Plan ES2402 for Pre-stressed Concrete Track Tie or ES2403 and ES2407 (for bridge deck locations requiring a neoprene pad). Ties shall be new unless indicated otherwise in the Contract Documents.

### **2.06 RAIL**

- A. Rail shall conform to the requirements of Section 34 11 10.

### **2.07 OTHER TRACK MATERIAL (OTM)**

- A. OTM shall be new and conform to requirements of Section 34 11 15 and SCRRA Engineering Standards.

### **2.08 TURNOUTS**

- A. Special Trackwork shall conform to the requirements of Section 34 11 23.
- B. Turnouts shall be as indicated on the Contract Plans, fabricated with all new Material, and in conformance with SCRRA Engineering Standards.
- C. Derails shall be of constructed using new Material and conform to SCRRA Engineering Standards with type (double switch point derail or sliding derail with crowder) as indicated in the Contract Documents.

**2.09 GRADE CROSSING PANELS**

- A. Road Crossings shall be of new Material and conform to Section 34 11 40 and SCRRRA ES4201 and as indicated on the Contract Plans.

**2.10 LUBRICANTS**

- A. Lubricant for special trackwork shall be Whitmore's Railmaster Curve grease except that Dixon L-5550 graphite shall be used for switch plate lubricant. Approved equals shall be submitted for approval by the Engineer.

**2.11 INSULATED JOINTS**

- A. Insulated Joints shall be new and conform to requirements of Section 34 11 15 and SCRRRA Engineering Standards.

**PART 3 - EXECUTION****3.01 GENERAL REQUIREMENTS**

- A. Work shall be completed in accordance with SCRRRA Engineering Standard Plans, SCRRRA Track Maintenance Manual, AREMA Manual for Railway Engineering, and as specified herein.
  - 1. Each fully completed segment of track, as approved in the SSWP, that is to be placed into operational service shall fully comply with the requirements of FRA 49 CFR 213 for the specific classification of train operation.
  - 2. Track must have ballast section full to top of ties, have joints fully bolted or welded, have all anchors or elastic fasteners applied, and the rail shall be fully de-stressed.
- B. Bottom of rail, fastener assemblies, and all bearing surfaces shall be broom cleaned before laying rail.
- C. The low rail (inside rail of curves) on all superelevated tracks shall be designated as the profile rail.
- D. Install track, OTM, turnouts, derails and road crossings in accordance with the Contract Plans, SCRRRA Engineering Standards, SCRRRA Track Maintenance Manual and California Public Utilities Commission requirements.

**3.02 SUB-BALLAST**

- A. Sub-ballast construction shall conform to typical cross sections as depicted in SCRRRA Engineering Standards or as shown on Contract Plans and must also comply with the requirements of Specification Section 34 11 27.

**3.03 CROSS TIES**

- A. Wood or concrete ties shall be used in special trackwork, grade crossings, turnouts, and crossing diamonds as shown on the Contract Plans.
  - 1. Use of wood ties or concrete cross ties shall be designated on the Contract Plans for use in track construction as indicated.
- B. Ties damaged as a result of improper handling or installation by Contractor and rejected by the Engineer must be removed and replaced with new ties at no additional cost to the Authority.
- C. Installation and placement of wood ties shall be as follows:
  - 1. Place wood Crossties on 19-1/2" centers for mainline track, except through grade crossings.
  - 2. Space cross ties for grade crossings in accordance with the applicable SCRRA Engineering Standard.
  - 3. Space Crossties for turnouts in accordance with the applicable SCRRA Engineering Standard and the Contract Plans.
  - 4. Obtain approval for any deviation in crossties spacing from the Engineer prior to Installation of spikes or hold down devices.
  - 5. Place wood ties with heartwood face down and square to the rail, except as otherwise shown on the Contract Plans.
  - 6. When handling or spacing ties, prevent damaging them with picks or spiking hammers. Tie tongs, lining bars, other suitable tools or tie spacing equipment shall be used.
  - 7. Do not drive nails or spikes other than those called for into wood ties.
  - 8. Do not re-spike new wood ties.
- D. Place concrete Crossties as shown in the Contract Plans and SCRRA Engineering Standards.
  - 1. Ensure that the proper rail cant is established.
  - 2. Concrete Crosstie spacing shall be 24 inches centers.
- E. Transition ties shall be installed where concrete ties abut timber track in accordance with SCRRA Track Maintenance Manual and SCRRA ES2351-03.

- F. Bridge decks with less than 12 inches of ballast under the tie will require use of a concrete tie with embedded neoprene pad (SCRRA ES2403 or ES2407). When calculating the depth of ballast under the tie, include any HMA underlayment as a part of the ballast depth for determining the requirement for use of the concrete tie with embedded neoprene pad. Bridge decks with 12 inches or more of ballast under the ties will utilize standard concrete ties (SCRRA ES2402 or ES2406).

### 3.04 TIE PLATES

- A. Plates shall be positioned so that the rail will cant inward towards track centerline and the plate shall be centered on tie and applied as to obtain full proper bearing on both the tie and rail.
- B. Tie plates shall be installed as shown on the SCRRA Engineering Standards, in SCRRA Track Maintenance Manual, and on approved Shop Plans.

### 3.05 RAIL FASTENING

- A. OTM shall be installed in accordance with SCRRA Engineering Standards and where applicable, manufacturer's recommendations.
- B. Resilient fastening system shall be used for all new construction. Standard fastening system shall be used only for maintenance of the existing track constructed with cut spikes.
- C. Installation of screw spikes and specified resilient fasteners shall be in accordance with manufacturer's recommendations, and SCRRA Engineering Standards and SCRRA Track Maintenance Manual.
- D. Spiking for standard cut spike fastening systems shall be performed using new cut spikes unless otherwise indicated in the Contract Plans and as follows:
  - 1. Spiking pattern shall conform to SCRRA ES2460.
  - 2. Spikes shall be started vertically, square to the base of rail and driven straight.
  - 3. Shank of rail-holding spikes shall have full bearing against base of rail.
  - 4. Do not strike rail or fastenings when driving spikes.
  - 5. Bent spikes shall be removed and replaced with a new spike as approved by the Engineer.
  - 6. Spikes shall not be over-driven.
- E. Holes for the screw spikes shall be pre-drilled and applied perpendicular to the plane of the base of the tie plate.
  - 1. Sufficient torque shall be applied to bring the bearing face of the screw spike into flush bearing contact with the tie plate so no gap exists.

2. Not more than 2 each cut spikes per plate may be used to hold the elastic fastening system plates until the screw spikes are installed.
3. Cut spikes used in this manner as temporary fasteners may be salvaged or used material.
4. Cut spikes used as temporary fasteners in this manner shall not be removed; however four (4) screw spikes per plate shall be provided if cut spikes are used in this manner.

### **3.06 RAIL ANCHOR INSTALLATION**

- A. Rail anchors shall be installed per SCRRRA ES2351-01 through ES2351-04 and SCRRRA Track Maintenance Manual, as applicable.
  1. In applying rail anchors, they shall be set with full bearing against the side of the tie.
  2. Anchors shall not be over-driven.
  3. Fractured or spread rail anchors will be rejected.
  4. Rail anchors shall be applied prior to operation of trains.
  5. If, in accordance with the Engineer-approved SSWP, a slow order will be required, the Contractor must submit proposed anchor pattern to the Engineer for approval prior to commencement of the rail anchor work.
  6. Anchors shall be removed and re-applied at the time CWR is de-stressed.
- B. Rail anchors shall be applied in accordance with manufacturer's recommendations.

### **3.07 INSTALLING TRACK**

- A. Installation, laying, raising, lining, tamping and dressing of track over ballast shall be performed as follows:
  1. Ballast shall only be installed over sub-ballast, which has been prepared in accordance with Section 34 11 27 and approved by the Engineer.
  2. Place base ballast in lifts not more than 6 inches in thickness before compaction.
    - a. Layers shall extend beyond the edge of the ties as shown on the Contract Plans before compaction.
    - b. Compact ballast thoroughly to form a stable section able to support the subsequent layers and loads.
  3. Compaction of base ballast shall be by means of vibratory compaction equipment specified in Division 01.

- a. Each lift of ballast within the initial layer shall be uniformly spread and compacted with not less than four passes of either a self-propelled, pneumatic-tired roller or vibratory compactor.
  - b. Ballast surface that exhibits ruts or crowns is not acceptable and shall be re-graded and re-compacted prior to the placement of the crossties.
4. Obtain the Engineer's verification of the compacted ballast prior to the installation of track and appurtenant Work over the ballast.
  5. The track shall be assembled on the compacted ballast to permit placement of additional ballast for subsequent raising and tamping and to provide the full depth under the ties.
  6. The ballast shall be tamped with a 16-tool vibrating squeeze-type mechanical tamper specified in Division 01, making a minimum of one full tamping insertion per tie for each inch of raise.
  7. The final track raise shall not exceed 1 inch.
  8. The ballast in the crib areas shall be mechanically stabilized by a dynamic ballast stabilizer approved by the Engineer in accordance with Division 01.
  9. The track shall be raised, aligned and tamped to within the specified tolerances.
  10. Ballast shall be thoroughly tamped within a space from 15 inches inside either rail to the ends of the ties.
    - a. In tamping ties within the above-described limits, simultaneous tamping shall be performed under each rail.
    - b. Tamping is not permitted at the center of the tie except within limits of turnouts and crossings where the center of the ties shall be tamped unless prevented by trackwork components.
  11. Pneumatic or electric tamping tools, either handheld or machine mounted shall be used to perform tamping at portions of turnouts not accessible to a production tamper. Hand tamping with shovels or picks will not be permitted unless authorized by the Engineer.
  12. Two tamping tools shall always be used opposite each other on the same tie.
    - a. Tampers shall be started from a nearly vertical position and worked downward past the bottom of the tie, after which the tool should be slanted downward to force ballast under the tie.
    - b. Double tamp every joint tie.

13. Ballast shall be mechanically dressed to provide the section as shown on the SCRRA Engineering Standards and the Contract Plans.
14. Excess ballast shall be removed.
  - a. With the Engineer's permission, excess ballast may be placed as directed by the Engineer.
  - b. Payment will not be made for ballast in excess of dimensions shown on the Contract Plans.
15. Ballast damaged by overwork or excessive tamping or fouled by dirt or other deleterious material as determined by the Engineer must be removed and replaced at no additional cost to the Authority.
16. Where new track joins existing track, the existing track shall be surfaced for a minimum distance of 500 feet on mainline or siding tracks, or 200 feet on industrial tracks, from the point of connection.
  - a. Existing track surfacing may be longer as needed to meet FRA requirements, or as shown of the Contract Plans.
17. After the track has been raised to its final elevation and super-elevation, ballast consolidation of all tracks shall be performed before the track is placed in service.
  - a. Each segment of track may be placed in full service, as approved in the SSWP, if that segment fully complies with FRA 49 CFR 213 for specific classification of train operation, has ballast section full to top of ties, has joints fully bolted or welded, has all anchors or elastic fasteners applied, and has the rail fully de-stressed and ballast compacted.
18. When raising track, a spot board or other approved device shall be used to maintain grade, and a level shall be used to keep track to proper cross-level.
  - a. Laser guided alignment is required, and horizontal alignment must be maintained during the raising operation.
  - b. Use of automated controls on tampers will satisfy this requirement.
19. In addition to the other requirements specified herein, all newly constructed mainline and mainline siding tracks, upon completion of final surfacing operations, shall be mechanically stabilized using a Ballast Stabilizer as specified in Division 01.

### **3.08 INSTALLING TURNOUTS**

- A. Installation of frog plates, switch plates, and plates under the closure rails shall conform to SCRRA Engineering Standards and AREMA trackwork standards.

1. Plates shall be secured by screw spikes except rehabilitation of existing turnouts with cut spikes, which shall be fully spiked.
- B. Following the installation of turnouts on the initial layer of ballast, the turnouts shall be lifted, aligned and supported prior to placement of final ballast.
- C. Ballast shall be uniformly placed and spread.
1. The turnout shall then be raised and the ballast tamped under both sides of each tie for the full length of the tie.
  2. Tamp ballast thoroughly throughout the length of all ties in the turnout or other special trackwork.
  3. Final top of ballast shall conform to the ballast section as indicated except in cribs wherein switch operating rods, locking rods or connecting rods are located and between point of switch and heel of switch where the crib ballast shall be 3 IN below the base of the rail.
- D. When installing the various components of the turnout, particular attention shall be given to the following:
1. Check that alignment, gage, and surface meet Specifications.
  2. Verify that bolts, nuts, cotter pins, and other fastenings are in place, in good condition, and properly tightened.
  3. Verify that switch points are properly aligned and fit tightly against rail when switch is thrown in either position.
  4. Verify that connecting rod and switch rod bolts are equipped with cotter pins properly applied.
  5. Test-operate the switches for lost motion, difficult throw, or loose connections and adjust as necessary.
  6. Examine the rod and fastenings that connect the switch point to the switch stand to see that they are in place and in good condition.
- E. Joints within turnouts shall be welded.
- F. Switch stands shall be so installed as to hold the switch point tightly against the stock rail when stand is in normal position, per the manufacturer's instructions.
1. Switch rods shall be adjusted to hold the opposite point tightly against the rail when stand is in reverse position.
  2. Switch stands, for both switches and derails, shall be mounted on two headblock ties. Headblock ties shall conform to the requirements of SCRRR ES8740.



- G. Switch stands shall be kept securely fastened to the head block ties, use approved screw spike fasteners.
  - 1. The head block ties shall be set square with the track and kept firmly tamped.
  - 2. Correct any walkway deficiencies adjacent to the head block ties that would impact SCRRA employee or operating personnel access to the operating levers or controls for the switch stand.
- H. Switch stand target colors shall conform to SCRRA ES2610 for Derail Switch Target or to SCRRA ES2703 for Standard Switch Target.
- I. At the time of Installation, sliding surfaces of special trackwork assemblies shall be lubricated with a dry film graphite lubricant in accordance with the manufacturer's recommendations.
- J. Insulated joints for non-interlocked switches shall be installed as shown on the Contract Plans and in accordance with AREMA (Former AAR) Signal Manual.
  - 1. Install joint using manufacturer's recommended procedure.
- K. Signal System Point Protection:
  - 1. No switch point shall be installed in the main track unless it has the proper signal system point protection in place and tested.
  - 2. No switch protection shall be removed from any normally closed signaled switch point unless the switch point is replaced by a straight rail and signal circuits have been corrected and tested.
  - 3. All rail bonding and fouling circuit protection must be intact at all times on all signaled switches.
  - 4. SCRRA, through their on-call signal and communications contractor, will perform installation and testing of signal devices, unless otherwise specified in Contract Documents.
  - 5. Contractor must coordinate installation or removal of turnout with SCRRA Engineer for required signal testing.

### **3.09 INSTALLING DERAILS**

- A. Install derails per manufacturer's instructions at locations designated in Contract Plans and in accordance with SCRRA Engineering Standards.

### **3.10 DRILLING**

- A. Rail ends for bolted joints shall be drilled in accordance with SCRRA Track Maintenance Manual, 5.2.3.
  - 1. Any additional holes in rail will be sufficient cause for rejection.

- B. A variation of 1/32" in size and location of bolt holes will be allowed.
- C. Holes shall be located with the proper size rail-drilling template and marked with a center punch prior to drilling.
- D. Drilling through joint bars is prohibited.

### 3.11 RAIL ENDS

- A. Rail shall be cut with rail saw to a tolerance of 1/32" from square.
  - 1. All burrs shall be removed and ends made smooth.
  - 2. Torch cut rails will be rejected.
- B. Battered or mismatched ends shall be built up or ground off to conform to minimum tolerance of 1/16" on top and gage side to adjoining rail.

### 3.12 RAIL END HARDENING

- A. At all rail end locations not eliminated by field welding, rail ends shall be field end hardened in accordance with the AREMA Manual, Volume 1, Chapter 4, Section 2.1.17.1, "Supplementary Requirements" including all insulated joints.

### 3.13 PROCEDURES FOR PLACEMENT OF CWR

- A. SCRRRA procedures for the installation, adjustment, maintenance, and inspection for CWR as required by 49 CFR213.119 are included in Section 9.0 of SCRRRA Track Maintenance Manual. Procedures for tie installation, surfacing operations, CWR installation procedures, rail anchoring requirements, track buckling prevention, monitoring curve movement following track surfacing and lining, placing temporary speed restrictions for trackwork, rail joint inspections, extreme weather inspections, training, and record keeping are included in this Manual.

The Manual is available on SCRRRA's website at the following link: <https://metrolinktrains.com/globalassets/about/engineering/scrra-track-maintenance-manual.pdf>. The Contractor shall refer to this manual for all procedures for placement of CWR.

- B. ANCHORING CWR

Procedures shown in Section 9.7 of SCRRRA Track Maintenance Manual shall be used for anchoring CWR.

- C. HEATING RAIL

Heating rail shall be as per procedures shown in Section 9.6.3.5 of SCRRRA Track Maintenance Manual.

- D. THERMAL ADJUSTMENT

The preferred rail laying temperature, temperature differential, maintaining Preferred Rail Laying Temperature (PRLT) in CWR track, methods for determining PRLT adjustment, CWR movement chart, and instructions for taking rail temperature, monitoring rail movement are included in Section 9.6 of SCRRA Track Maintenance Manual. These procedures shall be used for thermal adjustment of CWR.

E. RECORDKEEPING

Records necessary to provide an adequate history of installing and achieving CWR shall be maintained as required in Section 9.14 of SCRRA Track Maintenance Manual. Reports will be submitted to SCRRA and review and approval.

F. PROCEDURES FOR PLACEMENT OF JOINTED RAIL

1. Permanent construction and rehabilitation of jointed rail shall be carried out as per SCRRA Track Maintenance Manual. The procedures for ties and fasteners, rail handling and placement, rail joints, rail drilling, welding and track inspection are covered in SCRRA Track Maintenance Manual. These procedures shall be used for placement of jointed rail if included in the contract documents.
2. Jointed rail used during CWR installation process shall be constructed as per Sections 9.6.3 and 9.11 of the SCRRA Track Maintenance Manual.

### 3.14 TRACK CRITERIA AND TOLERANCES

- A. Track shall be constructed to the alignment and grade prescribed.
1. Gage shall be 4' - 8½".
  2. Deviation from established gage and cross-level shall not exceed 1/8", and profile grade and horizontal alignment variation shall not exceed 1/8" measured at the center of a 62 feet chord.
- B. Provide vertical and horizontal control stakes every 50 feet on curves and every 100 feet on tangents.
- C. Tangent track shall be level and superelevation and runoff spirals shall be provided on all curves in conformance with SCRRA ES2201 through ES2204 unless otherwise indicated in the Contract Plans.
- D. Contractor must not cut rail strings except as required to fit rail to turnouts, crossings or limits of work.

- E. A thermometer designed to measure rail temperature shall be used in accordance with SCRRA Track Maintenance Manual during rail Installation to assure compliance with the SCRRA Preferred Rail Laying Temperature. Refer to Section 9.6.1(Preferred Rail Laying Temperature) of SCRRA Track Maintenance Manual for additional information.

### **3.15 WELDING OF CONTINUOUS WELDED RAIL**

- A. Rail welding shall be in accordance with the approved procedure and Section 34 72 30, Field Welding Rail.

### **3.16 WALKWAYS**

- A. CPUC walkways shall be provided within track work limits in accordance with the Contract Plans, SCRRA ES2105 and ES2109, SCRRA Track Maintenance Manual, and CPUC General Order No. 118.
- B. Installation of walkways are incidental to installation of track.

### **3.17 INSULATED JOINTS**

- A. Each insulated joint installed by the Contractor must be tested with an insulated joint tester, either the Harmon 1501A1JC or equal approved by the Engineer.
  - 1. Test shall measure no less than 100 ohms across the joint.
  - 2. Test results shall be uniquely identified with a specific joint and submitted to the Engineer in Compliance Record.
- B. The rail ends at each insulated joint shall be beveled and hardened in accordance with the manufacturer's procedures as approved by the Engineer.
  - 1. Contractor must comply with rail end hardening and beveling requirements specified in this Section.

### **3.18 INNER GUARD RAILS**

- A. Inner Guard Rails will be required:
  - 1. For all bridge spans where exposed structural steel is present above the top of rail.
  - 2. Where individual spans are over 100 feet in length
  - 3. Where entire structure is over 800 feet in length and at least one span crosses over a waterway that normally contains water which is at least 15 feet deep.
  - 4. On any bridge as directed by SCRRA or the Contract Documents.

- B. Inner Guard Rails shall extend 50 feet beyond the span or spans to be protected as required above. SCRRA ES2302 and ES2304 indicate details for construction of Inner Guard Rails. Inner Guard Rails require use of special Concrete Ties as shown in ES2406 and ES2407.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Trackwork 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 34 11 10, Continuous Welded Rail (CWR); 34 11 15, Other Track Materials (OTM); 34 11 23, Special Trackwork; 34 11 16, Ballast; 34 11 27, Sub-Ballast and Aggregate Base; 34 11 33, Concrete Railroad Ties; 34 11 34, Wood Railroad Ties; 34 11 36, Elastic Rail Fasteners; 34 11 40, Precast Concrete Grade Crossing Panels; and 34 72 30, Field Welding Rail 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.
- C. Trackwork will be measured by the individual unit constructed in accordance with the Contract Documents and as measured by the Engineer.
  - 1. The quantities included in the approved Schedule of Quantities and Prices, or Schedule of Values as derived from the plans will be used as the basis for this measurement for new track construction.
  - 2. The quantities included in the approved Schedule of Quantities and Prices, or Schedule of Values as derived from the plans will be used as the basis for this measurement for rehabilitation or repair of track.
  - 3. Unless otherwise noted, the construction of special trackwork, from point of switch to last switch tie, and track constructed at grade crossings will be counted separately per complete unit as designated in the Schedule of Quantities and Prices.
  - 4. Measurement limits for various trackwork items will not overlap.

### **4.02 PAYMENT**

- A. Trackwork 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. Trackwork constructed, rehabilitated, or repaired in accordance with the Contract Documents will be paid for at the contract unit price(s) as listed in the Schedule of Quantities and Prices.
1. Payment for Trackwork will be made only upon documentation of fully completed trackwork and full restoration of track speed to the design speed as shown in the Contract Plans.
  2. All work must be complete prior to payment being made, including but not limited to welding, distressing, final surfacing, and completion of punch list items related to track work.

**END OF SECTION 34 72 00**

## SECTION 34 72 20

### TRACK SHIFTING, RELOCATION, AND RESURFACING

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Furnish all supervision, labor, materials, equipment, transportation and incidentals necessary to shift, relocate or resurface railroad track as shown on the Contract Plans and specified herein. Railroad track as used herein is defined as” an assembly of rails, ties and fastenings over which cars, locomotives and trains are moved.” This “track” assembly includes, the rail, ties, special trackwork, other track material (OTM), ballast, and walkways although not an exclusive listing.
- B. Section 34 72 00 will govern track construction work associated with this Section.
- C. 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 34 11 10 – Continuous Welded Rail (CWR).
  - 4. Section 34 11 15 - Other Track Materials (OTM).
  - 5. Section 34 11 23 – Special Trackwork.
  - 6. Section 34 11 26 - Ballast.
  - 7. Section 34 11 27 - Sub-Ballast and Aggregate Base.
  - 8. Section 34 11 33 - Concrete Railroad Ties.
  - 9. Section 34 11 34 - Wood Railroad Tie.
  - 10. Section 34 71 50 – Highway-Rail Grade Crossings.
  - 11. Section 34 72 00 - Trackwork.
  - 12. Section 34 72 30 – Field Welding Rail.

##### 1.02 REFERENCES

- A. Full compliance with applicable rules, regulations, and General Orders of California Public Utilities Commission is required. Representatives of that State agency will inspect railroad related work for compliance with General Orders.

- B. American Railway Engineering and Maintenance of Way Association (AREMA): Manual of Railway Engineering.
- C. AREMA Portfolio, American Railway Engineering and Maintenance of Way Association, Portfolio of Trackwork Plans.
- D. FRA:
  - 1. 49 CFR Part 213, Track Safety Standards, most current and addenda, Federal Railroad Administration
  - 2. 49 CFR Part 214, Railroad Workplace Safety, most current and addenda, Federal Railroad Administration
- E. CPUC, California Public Utilities Commission General Orders.
- F. SCRRA, Southern California Regional Rail Authority
  - 1. Engineering Standards.
  - 2. Track Maintenance Manual (Current Edition).
  - 3. Maintenance of Way Safety Rules.
  - 4. Design Criteria Manual
- G. GCOR, General Code of Operating Rules for Maintenance of Way employees.

### **1.03 SYSTEM DESCRIPTION**

- A. Perform all track shifting, relocation and resurfacing work as shown on the Contract Plans, and in accordance with this Section.
  - 1. Prior to shifting or relocating track, all drainage structures and grading, including placement of Sub-Ballast as per Section 34 11 27 shall be completed and accepted by the Engineer.
  - 2. In addition the other requirements specified herein, shifted, relocated, and resurfaced track shall be stabilized using a dynamic Ballast Stabilizer in accordance with Division 01.
  - 3. Following shifting, relocating, resurfacing and stabilizing of track, rail shall be distressed in accordance with SCRRA Track Maintenance Manual Section 9.0.
  - 4. Track shifting shall include all work to shift existing track more than 1 foot and less than 10 feet and providing Ballast per Section 34 11 26, resurfacing and regulating track in its new location.
  - 5. Track relocation shall include all work to relocate existing track a distance greater than 10 feet including installation of Ballast per Section 34 11 16, resurfacing and regulating track in its new location.



6. Resurfacing, shall include shifting of existing track up to 1 foot, and involves resurfacing indicated track and all special trackwork, including lining, raising, tamping, and regulating track in conformance with SCRRRA engineering standards, provisions of this specification, and to the lines and grades shown on the Contract Plans. The Ballast per Section 34 11 16 required to fill cribs and provide adequate shoulders must be provided by the Contractor.
  7. Rough and final surfacing of the entire track section shall be performed as required to provide minimal profile smoothing and adjustment. This surfacing may include providing and placing Ballast per Section 34 11 16, tamping, stabilizing and regulating ballast.
- B. The Contractor, as with any Work within the SCRRRA Right of Way, must submit a SSWP for each track segment that requires shifting, relocating, or resurfacing the active track in accordance with Division 01, Coordination with SCRRRA.

#### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00, Submittal Procedures:
1. Refer to Division 01, Coordination with SCRRRA, for submittal of applicable SSWP.
  2. Refer to Division 01 for submittal of personnel resumes and railroad equipment list.

#### **1.05 QUALITY ASSURANCE**

- A. Quality Assurance:
1. Contractor must perform track shifting, relocating, and surfacing under supervision of a qualified Railroad Construction Project Manager, Railroad Track Construction Manager, and Track Foreman. Work shall be performed by personnel experienced in similar railroad track work, as required under Division 01. The surfacing crew shall include a ground man, with a minimum of six months experience, qualified to check profile and alignment behind the tamper.

#### **1.06 PROJECT CONDITIONS**

- A. This work may occur on an active railroad track.
- B. The Contractor must coordinate all phases of the Work to prevent undue interference with the SCRRRA daily operations, or with other phases of the Project, whether performed by SCRRRA forces or another contractor's forces.

**PART 2 - PRODUCTS****2.01 GENERAL**

- A. Materials to be installed under this Contract must be provided by the Contractor unless indicated otherwise in the Contract Documents.
- B. Materials damaged or broken prior to or during installation must be replaced at the Contractor's expense with no additional cost to SCRRA.
- C. Labor, material not furnished by SCRRA, or equipment required for track resurfacing but not expressly shown on the Contract Plans shall be as if shown on the Plans and included in the Contractor's bid price.
- D. Material must be new, except as otherwise indicated herein, and meet the requirements stated herein and of the AREMA and SCRRA Standards.

**PART 3 - EXECUTION****3.01 GENERAL**

- A. Contractor personnel and equipment shall meet the requirements set forth in Division 01.
- B. Contractor must exercise care in his progression of work under this Contract to avoid and prevent damage to the track being shifted, relocated, or resurfaced, adjacent tracks, and structures and facilities, such as existing pavements, pavement bases, drainage structures, light poles, fire hydrants, signal facilities (track wires, bootlegs, signal masts, guy wires, signals, cables, conduits) utilities, signage and buildings. Contractor must repair or replace damaged structures or facilities to satisfaction of the owner at no cost to SCRRA, except that SCRRA will repair and test signal facilities at the Contractor's sole expense. The Contractor must be responsible to coordinate his work with SCRRA to arrange for the timely and orderly removals or relocations of this signal equipment and facilities. Failure of the Contractor to provide reasonable and adequate coordination for timely removal and relocation of signal facilities will not allow for an extension of time or provide grounds for extra cost to SCRRA.
- C. Contractor must perform Work under this Section in accordance with these Specifications and consistent with track resurfacing standard industry practice.
- D. Contractor must periodically review the supply of materials, labor and equipment to ensure a uniform flow of work. Contractor must keep the Engineer informed regarding material shortages or developing problems that require corrective action.
- E. Shifted, relocated, and resurfaced track shall meet the following tolerances as well as the standards for FRA 49CFR213 class 5 track.

1. Except for pre-existing rail gage wear,
  - a. Deviation from correct gage of 56-1/2" shall not exceed + or - 1/4 inch at any point.
  - b. Deviation measured in any section of 20 consecutive crossties shall not exceed 1/8 inches at 75 percent of the crossties, and 1/4" at the remaining 25 percent.
  - c. Newly installed or re-installed ties will be spiked not to exceed + or - 1/8" irrespective of pre-existing rail gage corner wear.

<b>TRACK SURFACE</b>	<b>TOLERANCE</b>
Runoff in any 31 FT of rail at the end of a raise may not be more than	1/4"
Deviation from uniform profile on either rail at the mid-ordinate of a 62 feet chord may not be more than	3/8"
Deviation from designated elevation on spirals may not be more than	1/4"
Variations in cross levels on spirals in any 31 feet may not be more than	1/4"
Deviation from zero cross level at point on tangent or from designated elevation on curves between spirals may not be more than	3/16"
Difference in cross level between two points less than 62 feet apart on tangents and curves between spirals may not be more than	3/8"

2. Alignment - maximum deviation from uniformity measured in conformance FRA Safety Standards Section, 213.55.
    - a. Tangent Track 1/4" - at mid-ordinate on a 62 feet chord.
    - b. Curved Track 1/4" - from correct mid-ordinate on a 62 feet chord.
- F. Elastic clips, rail anchors, and spikes shall be loosened prior to shifting track to prevent skewed ties. Rail, fasteners, or crossties damaged during track shifting must be replaced by the Contractor at Contractor's expense. Rail anchors are not to be slid longitudinally along the base of the rail. They must be removed prior to shifting track and reapplied in the correct location after track is shifted to its final location.

### **3.02 RESURFACING, ALIGNMENT AND DRESS**

- A. Contractor must perform shifting and resurfacing within the stated project limit station areas as specified to bring the line and surface into compliance within the track geometry tolerances specified.

- B. Contractor must resurface the track to zero crosslevel on tangent track and to the proper crosslevel elevation, with spirals, for the curves as shown on Contract Documents.
- C. Ballast shall be spread and track raised in a series of lifts. No single lift shall be higher than 2 inches except in crossings and turnouts. In raising the track, jacks or equipment shall be regulated to avoid bending of angle bars or straining of joints. When jacks are used they shall be simultaneously used and properly spaced at not more than quarter points of the rail to avoid breaks or bends in the rail when the track is raised. Both rails shall be raised simultaneously and to proper crosslevel by utilizing automatic tampers or standard track level boards with each set of track raising jacks. Each tie shall be tamped from 15 inches inside the rail to the end of the tie. Tamping shall not be permitted at the middle of a tie. Both ends of a tie shall be tamped simultaneously and tamping inside and outside the rail shall be done at the same time.
- D. Ties that become loose during track raise shall be placed in proper position, tie-plates properly placed, holes plugged with "Tight Spike" or approved tie plugs and spiked before tamping. During each track raise, track shall be uniformly tamped.
- E. After ballasting is completed and the track is resurfaced and lined, according to the tolerances, ballast shall be mechanically stabilized using a dynamic track stabilizer and ballast shall be trimmed neatly and surplus material shall be spread evenly along the ballast shoulder.
- F. After stabilizing is completed, rail shall be distressed in accordance with SCRRRA Track Maintenance Manual Section 9.8.
- G. Contractor must perform the necessary operations to ensure that all ties are at right angles to the track as practical with standard railroad procedures. Cribs between ties shall be fully ballasted and dressed.
- H. Contractor must perform two tamping squeezes per tie up to two (2) inches of raise with one additional insertion and squeeze for each additional one (1) inch of raise. Joint ties shall be given one additional squeeze more than other ties. The Contractor must not cause a center-bound track condition.
- I. In locations where squeeze tampers cannot fill and compact ballast, such as but not limited at frogs, guard rails, switch portions of turnouts and headblocks, mechanically tamp with approved hand-held air tools or other power tamping tools. Hand tamping shall be done simultaneously from both sides of the tie.
- J. On curves, the high rail shall be used as the line rail and the low rail shall be used as the grade rail.
- K. When surfacing turnouts, the straight side of the turnout shall be used as the line rail.
- L. After ballast regulating in turnouts, cribs for switch points, switch rods, and guardrails shall be pocketed 3 inches and cleared of ballast to permit free operation of the switch and signal rods.

- M. After the ballast is regulated, dressed and consolidated using a track stabilizer, Contractor must ensure that track bolts and rail anchors, or elastic track fasteners are tight and in proper alignment.
- N. For track resurfacing the total track raise will be the minimum amount necessary to smooth the track profile. It shall be the responsibility of the Contractor to provide smooth transitions that meet the required surfacing tolerances as listed above to grade crossings and turnouts, using the ballast stockpiled near the worksite. In addition, the Contractor must maintain vertical overhead clearances under structures by limiting the amount of track raise. Adjustment of turnouts and connecting tracks to match profile and alignment adjustments on adjacent track must be provided by Contractor at no additional expense.
- O. Any temporary surfacing runoffs made to accommodate interim rail traffic prior to completion of track surfacing must meet FRA Track Class 5 Standards.

### **3.03 WALKWAYS**

- A. Walkways shall conform to SCRRRA Engineering Standards ES2109 and General Order No.118-Public Utilities Commission of the State of California.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Track shifting 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. Surfacing, stabilizing and de-stressing of shifted track is incidental to this item and will not be measured.
- B. Track Relocation 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. Surfacing, stabilizing and de-stressing of shifted track is incidental to this item and will not be measured.
- C. Track Surfacing 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. Surfacing, stabilizing and de-stressing of shifted track is incidental to this item and will not be measured.
- D. All material, work and services included in Sections Other Track Materials (OTM); 34 11 16, Ballast; 34 11 17, and Sub-Ballast and Aggregate Base; 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.

- E. Work of shifting, relocating and resurfacing existing track will include furnishing all labor, materials, tools, equipment, supplies, supervision, installation of Contractor provided ballast and walkway rock, laser aligned tamping, resurfacing, regulating, stabilizing and de-stressing to SCRRA standard cross section and any other incidental work necessary for shifting, relocating and resurfacing existing track as described in the Contract Documents.

#### **4.02 PAYMENT**

- A. Track shifting, relocating and resurfacing 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, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

**END OF SECTION 34 72 20**

## **SECTION 34 72 30**

### **FIELD WELDING RAIL**

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

##### **1.01 SUMMARY**

- A. This Section consists of the Contractor performing field welding of continuous welded rail (CWR) strings using the flash butt welding process or approved thermite-welding method.
- B. The Contractor must make assessment as to the number of welds, including the method of welding for each weld, to be performed under this Contract.
- C. 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 34 72 00 - Trackwork.
  - 4. Section 34 72 20 - Track Shifting, Relocating and Resurfacing.

##### **1.02 REFERENCES**

- A. SCRRRA: Engineering Standards, and Track Maintenance Manual.
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
  - 1. Manual for Railway Engineering
- C. FRA: 49 CFR Part 213, Track Safety Standards, most current and addenda, Federal Railroad Administration.
- D. ASTM International (ASTM):
  - 1. ASTM E164 Standard Practice for Ultrasonic Contact Examination of Weldments.

##### **1.03 SUBMITTALS**

- A. Submit under the provisions of Division 01:
  - 1. Procedure: Submit proposed materials, methods and procedures to be used for mobile flash butt field welding of CWR, including:

- a. Manufacturer's trade name and technical data for the welding process, including welding machine performance standards.
  - b. Method of welding high strength rail if different from requirements for standard rail.
  - c. Methods of transporting material and mobile equipment to the site and duration of welding operations.
  - d. Method used for cutting and cleaning to parent metal of the rail ends.
  - e. Minimum and maximum spacing between rail ends.
  - f. Method used for maintaining the rails in alignment during welding.
  - g. Method used for grinding and contouring rail removing weld upset following the welding process.
2. Procedure: Submit proposed methods and procedures to be used for thermite welding of CWR, including:
- a. Manufacturer's trade name and technical data for the welding process.
  - b. Method used for cutting and cleaning of the rail ends.
  - c. Minimum and maximum spacing between rail ends.
  - d. Method used for maintaining the rails in alignment during welding.
  - e. Method used for preheating the rail ends including time and temperature.
  - f. Tapping procedure including the minimum time required to cool the weld under the mold insulation.
  - g. Method used, including a description of special tools and equipment for removing the gates and risers and finishing the weld to the final contour.
3. Refer to Division 01 for submittal of resumes for individual(s) directly supervising, inspecting, and performing field welding of rail.
4. Procedure: Submit rail end hardening procedure.
5. Testing: Submit testing company qualified in use of the Ultrasonic testing method in accordance with ASTM E164.
6. Field Weld Record: Submit as specified herein.



## 1.04 QUALITY ASSURANCE

- A. Provide qualified personnel for supervision and performance of work in accordance with Division 01.
- B. Perform certification testing of all welds to ensure that Work is performed in accordance with the Contract Documents, and within the tolerances provided herein.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. For electric flash butt welding, materials, equipment and process shall be as provided by Holland L.P. or other approved equivalent.
- B. For thermite welding, Materials and equipment shall be as manufactured by "Boutet," "Orgotherm," "Elektro-Thermite," or other approved equivalent for standard or high strength (alloy or heat treated) rail, as appropriate.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Electric flash butt welding, methods and procedures shall comply with the AREMA Manual, Volume 1, Chapter 4, Section 2.3, Specifications for the Quality Assurance of Electric-Flash Butt Welding of Rail.
- B. Thermite welding, methods and procedures shall comply with the AREMA Manual, Volume 1, Chapter 4, Section 2.5 Specification for the Quality Assurance of Thermite Welding Rail, with the welding kit manufacturer's recommendations, and as specified herein.
- C. Rail ends for thermite welding shall be prepared in accordance with the recommendations of the welding kit manufacturer.
- D. For thermite welding, the rail ends shall be preheated prior to welding to a sufficient temperature and for sufficient time to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.
- E. The completed weld shall be finished by mechanically controlled grinding to conform to the same requirements specified for shop welding.
- F. Thermite welds shall not be made at the following locations:
  - 1. Within 6 inches of the edge of any bolt hole in the rail.
  - 2. Within 6 inches of a Cadweld or copper bond wire (If this type of bond exists, remove any presence of copper by grinding. The rail ends must be inspected and cleaned after grinding is complete).

3. Closer than 3 feet from an existing plant weld.
  4. Closer than 19.5 feet to an existing thermite weld.
  5. On both ends of a rail plug simultaneously unless the rail is 15 feet or longer on tangent track and 24 feet long or longer on curved track.
- G. Follow Manufacturer recommendations for compromise welds.
- H. Follow recommendations of rail manufacturer for welding high strength (alloy or heat-treated) rails.
- I. Thermite welds shall be located in cribs between ties. The edge of the weld must be no closer than 3 inches from the edge of the nearest tie.
- J. Electric Flash Butt welds with the base of the rail smoothly ground may be located anywhere.

### **3.02 FIELD WELDING RECORD AND RAIL MARKINGS**

- A. Field welding record shall be continuously maintained and furnished to the Engineer within seven (7) workdays of completing the weld. The record shall include the following minimum details, noting that a different recording and marking procedure will be required for free end welds or for destress welds used to close up openings in rail:
1. Date and time of weld(s).
  2. Location by station, specifying track and rail.
  3. Contractor foreman initials.
  4. Weather, air and rail temperature for destress welds (welds made to close up rail).
  5. Track condition, anchorage and rail stress for destress welds, or the word "FREE" for free end welds.
- B. Rail shall be permanently marked on the web of rail in legible characters at least 1-1/2 inches high at each field weld with the above information in accordance with Section 5.16, Marking Thermite Welds of the SCRRA Track Maintenance Manual. If an existing destress weld is located within 400 feet of a new destress weld, lines shall be marked through the old weld's marking and an arrow marked indicating the direction towards the new destressed weld.

### **3.03 TOLERANCES OF FIELD WELDS**

- A. A straight edge 36 inches in length, applied to finished welded joint area shall be used to check for the following maximum variations (measurements shall be taken with a 6 inches steel taper gauge):
1. Rail Head:

- a. Vertical Offset: 0.020 inches.
  - b. Horizontal Offset: 0.040 inches.
  - c. Vertical Crown: 0.40 inches ofr Thermite and 0.60 inches for In-Track.
  - d. Horizontal Kink: 0.025 inches.
2. Rail Base:
- a. Horizontal Offset: 0.060 inches.
  - b. Vertical Offset: 0.25 - 0.125 inches.

### **3.04 FINISHING OF FIELD WELDS**

- A. Sharp edges and burrs shall be removed, including chimneys from thermite welds. Top of base of rail shall be ground smooth at chimney locations.
- B. Weld joints shall be smooth on top and sides of head and straight in line. No over grinding is permitted. Web of rail at thermite welds shall not be ground. All mold residues shall be removed from the weld area and properly discarded.
- C. Finishing of welds shall be sufficient to allow testing using the Ultrasonic test method as described below. Welds rejected because of insufficient or unsatisfactory finishing of welds shall be refinished, repaired, or replaced at the Contractor's expense until the weld meets the testing criteria.

### **3.05 FIELD WELD TESTING**

- A. Fabricate CWR strings so that the branding of all individual rail section appears on the field side of installed track.
- B. Rail welds must be tested by the Contractor through the use of an SCRRA approved testing agency using the Ultrasonic testing method in accordance with ASTM E164 Technique 4 for use with thick weldments.
- C. Each completed weld shall have full penetration and complete fusion and be entirely free of cracks. Total area of internal defects such as porosity and slag inclusions shall not exceed 0.060 sq in and the largest single porosity or slag defect permitted shall not exceed 1/8 inches dia.
- D. Other causes for rejection of welds shall be:
  1. Cracks that show in the finished weld.
  2. Pit holes that show in web and base of weld after finish grinding. Pit holes in head not exceeding 1/4 inches in depth may, if approved by the Engineer, be repaired by gas welding.
  3. Over-grinding of weld.

- E. Welded joints not meeting these Specifications and tolerances will be replaced at no additional cost to the Authority. The defective weld shall be cut out, and a new section of rail of a length described in Article 3.06 herein shall be inserted, welded into place as described in this Section, and retested.

### **3.06 CUTTING IN SHORT SECTION RAIL AND THERMITE WELDING THE ENDS**

- A. A short section of rail shall be cut in the CWR, when required by the Engineer, for the following reasons:
  - 1. To repair defective rail(s).
  - 2. To repair defective weld(s).
  - 3. To destress rail.
  - 4. To make a connection between rail strings or adjust rail to meet a specific point (i.e. to connect CWR to stock rail or frog).
- B. The short section of rail to be cut in shall be at least 19 feet-6 inches long on tangents and curves less than 2 degrees; and 30 feet long on curves 2 degrees or greater and rail to be cut in shall be of the same weight, size, section, and class of rail being replaced or joined.
- C. Before cutting out rail in CWR and inadvertently losing all thermal control, prevent remaining CWR from further movement by applying full box anchors for at least 200 feet each way from the proposed cut. After cutting CWR, a rail expander/puller or other means shall be used to prevent rail movement until a weld or temporary joint is installed.
- D. The ends of the short rail section and the CWR shall be saw cut.
- E. Follow manufacturer's recommended procedures specified for completing field welding by thermite process.
- F. Repair of rail due to damage by Contractor shall be at Contractor's expense.
- G. When repairing a defective rail or weld, the new rail shall be the same length as rail being replaced, or as required to achieve thermal adjustment.
- H. When performing field welding, rail temperature adjustments shall be made in accordance with Section 34 72 00 using either heating of rail or mechanical rail pullers. The first weld of a replacement plug may be at ambient temperature, but the second (destress weld or rail closure weld) shall be installed in accordance with Section 34 72 00.

### **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 necessary for Field Welding Rail as described by the Contract Documents.

**END OF SECTION 34 72 30**

## SECTION 34 72 40

### TRACK COLLECTOR PAN SYSTEM

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION OF WORK

- A. Work Included: The work of this Section includes the furnishing and installation of a Track Collector Pan System at locations shown on the Contract Drawings.

##### 1.02 CERTIFICATION

- A. Except as otherwise specified, the Contractor shall submit for each of the materials furnished, certification by each manufacturer or producer that the material is in compliance with these specifications.

##### 1.03 SUBMITTALS

- A. Submittals shall comply with provisions of Section 01 33 00, Submittal Procedures shall include the following:
  - 1. Shop drawing, catalogue cuts and other data indicating proposed materials, details, layouts and construction information to the Engineer for review.
  - 2. Manufacturer's certification for all materials furnished.

#### PART 2 - PRODUCTS

##### 2.01 MANUFACTURER'S REFERENCE

- A. HDPE Enviropan®, as manufactured by Century Group, Inc. -- Sulpher, LA 1-800-527-5232
- B. Other manufacturers' product having equal characteristics and quality when approved by the engineer.

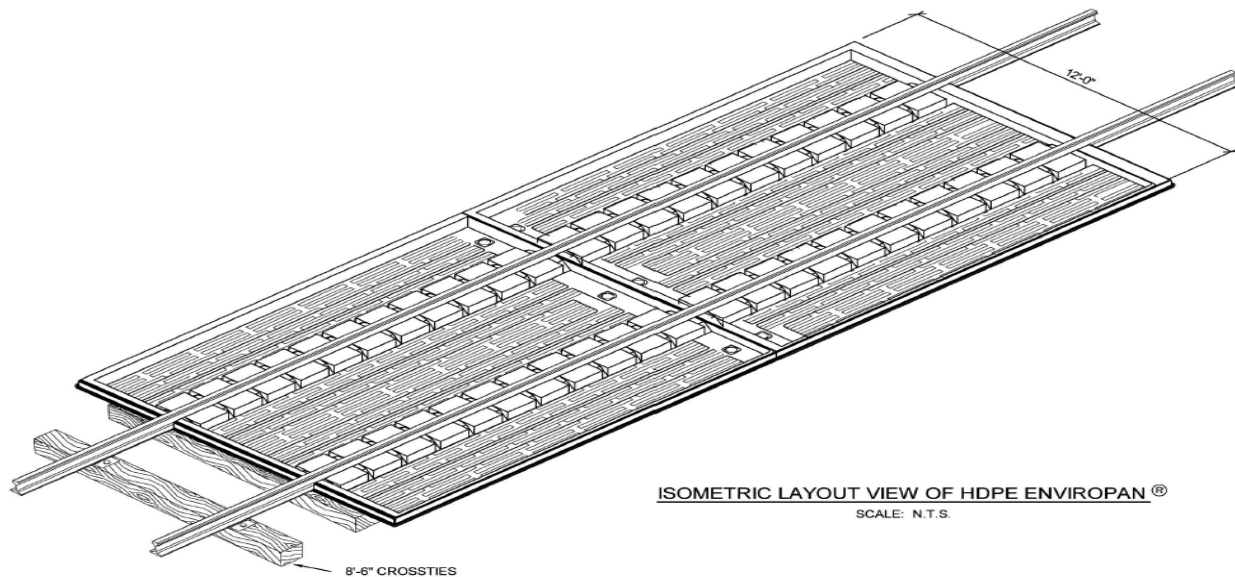
##### 2.02 MATERIALS

- A. The Track Collector Pan System shall be constructed from a series of pre-formed HDPE panels. The total assembly of panels shall form a 12-foot wide (cross track direction) and 90 feet long (down track direction) drip pan. Each 30-foot length of pan assembly shall consist of three panels: two are field side panels, with one gage panel between rails. Refer to diagrams at the end of this section.
- B. Physical Specifications:
  - 1. Temperature Range -100°F to +200°F

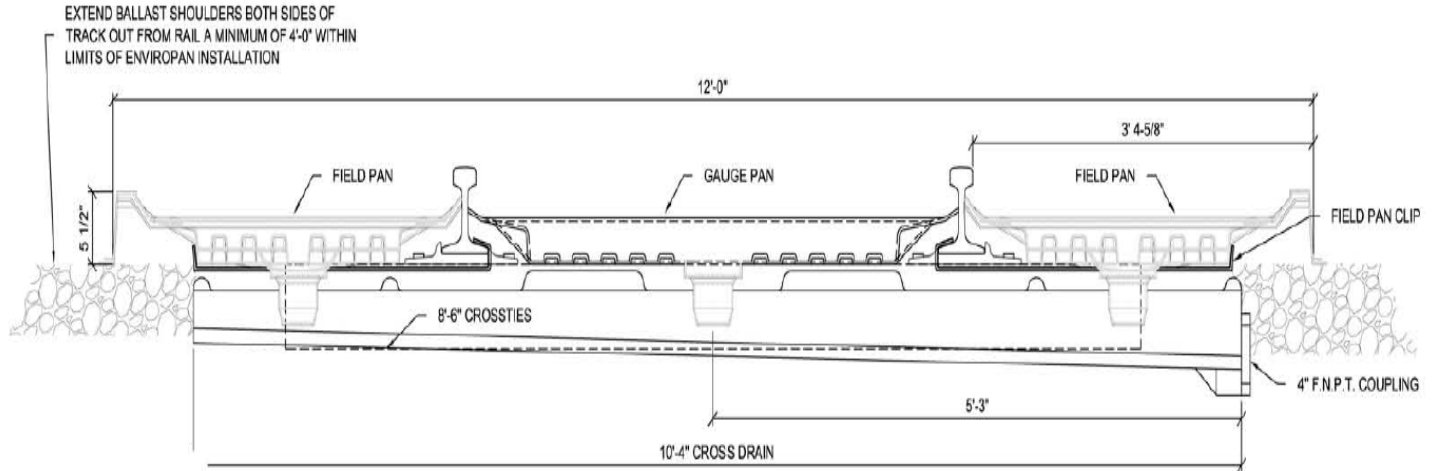
2. Volume Capacity 474 Gallons per 30` Section
  3. Weight ¼" Material Thickness Field Pan 68 lbs.
  4. Gauge Pan 93 lbs.
  5. Cross Drain 60 lbs.
  6. Tensile Strength at Yield 3600 psi
  7. Elongation at Break 600%
  8. Flexural Modulus 165,000 psi
  9. Tensile Impact 170 ft. lbs/in<sup>2</sup>
- C. B. The collector pans shall be connected by cross drains to a collector header pipe.
- D. The concrete mix is the proprietary information of the manufacturer. However, concrete compressive strength shall be no less than 4500 psi. If alternate manufacturer is proposed, material physical data shall be submitted with substitution request.

### 2.03 DESIGN & FABRICATION REQUIREMENTS

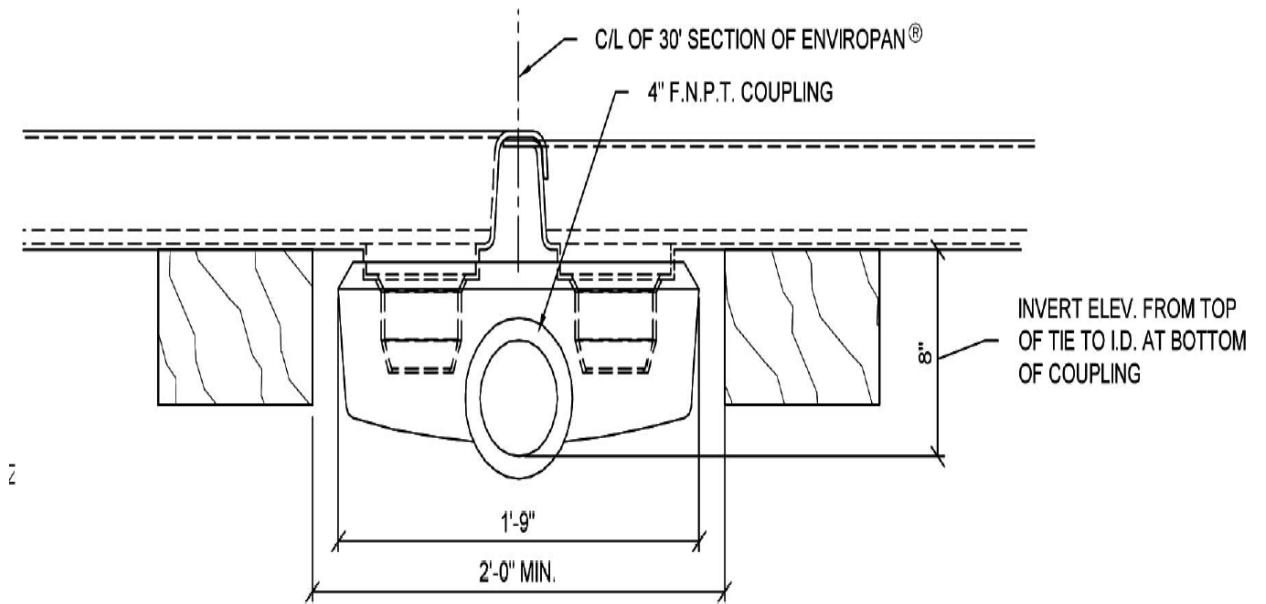
- A. Collector pans shall be fabricated from molds that provide a continuous, monolithic pan section.



### ISOMETRIC VIEW DETAIL OF PAN ASSEMBLY ACROSS TRACK



**SECTION VIEW OF PAN ASSEMBLY ACROSS TRACK**



**TYPICAL SECTION THRU CROSS DRAIN**

SCALE: 1" = 1'-0"



**PART 3 - EXECUTION****3.01 SITE STORAGE**

- A. Panels shall be stored on level, dry ground evenly supported every four feet using wood shoring.

**3.02 INSTALLATION**

- A. Unless otherwise specified, collector pans shall be installed in accordance with the manufacturer's installation instructions.
- B. Refer to Addendum 1 for complete installation details.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

- A. Track Collector Pan System work shall 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 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. Track Collector Pan System work completed in accordance with the Contract Documents will 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, and equipment to install track collector pans as recommended by the manufacturer including but not limited to center pans, side pans, end pans, and all other work necessary and incidental to construction of the track collector pan system.

**END OF SECTION 34 72 40**

## SECTION 34 80 11

### STONE REVETMENT (RIPRAP)

#### PART 1 - GENERAL

##### 1.01 SUMMARY

A. Section Includes:

1. Stone revetment (riprap) for protection of slopes against erosion.
  - a. Drainage outflow area.
  - b. Slope riprap.
  - c. Geotextile and sand cushion base.
  - d. Other areas indicated and shown on the Drawings.

B. Related 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.

##### 1.02 REFERENCES

A. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
  - a. M228, Standard Specification for Geotextile Specification for Highway Applications.
  - b. T103, Soundness of Aggregates by Freezing and Thawing.
2. ASTM International (ASTM):
  - a. C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
  - b. C127, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.

- c. C1116, Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
3. Corps of Engineers (COE):
  - a. CRD-C100, Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing.

### 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.
  3. Certifications.
  4. Test reports.
  5. Submit all tests and certification in a single coordinated submittal. Partial submittals will not be accepted.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Stone:
  1. Durable broken quarry run stone Apparent Specific Gravity minimum 2.50 ASTM C127.
  2. Does not disintegrate on exposure to water or weathering.
  3. Free from structural fractures and defects.
  4. Not containing shale, unsound sandstone, or other material which will disintegrate.
  5. Graded within limits specified.
  6. Breadth and thickness of any stone: Not less than one-third of its length.
  7. Ensure that dirt and fines accumulated from interledge layers or from blasting or handling operation is less than 2 percent by weight.

8. Gradation of the material:
- a. UngROUTED riprap to be loaded and quarried shall conform to the following limitations unless otherwise specified:

<b>RIPRAP CLASS</b>	<b>AVERAGE WEIGHT PER STONE (LBS)</b>	<b>DIMENSION (IN)</b>	<b>MINIMUM LAYER THICKNESS</b>
I	50 to 200	9 to 14	1' - 6"
II	200 to 1000	14 to 24	2' - 0"
III	1000 to 4000	24 to 38	3' - 0"
IV	> 4000	> 38	4' - 0"

- b. Grouted riprap shall have the following gradation:

<b>NOMINAL STONE SIZE (INCHES)</b>	<b>% OF MIX SMALLER THAN GIVEN SIZE (BY WEIGHT)</b>
21	70 to 100
18	50 to 70
12	0 to 5

9. The following allowances shall be acceptable to produce the required ungrouted riprap protection:
- a. Riprap Class I - No allowances permitted.
- b. Riprap Class II - 15 percent of riprap Class I.
- c. Riprap Class III - 15 percent of riprap Class I and 15 percent of Class II.
- d. Riprap Class IV - 15 percent of riprap Class I, 15 percent of Class II, and 15 percent of Class III.

10. Grouted riprap:
- a. Riprap shall be angular (not rounded), each rock having its greatest dimension not greater than 3 times its least dimension. Elongated rocks shall be hand adjusted to a vertical versus horizontal position.
- b. The specific gravity of the riprap rock shall be 2.5 or greater.
- c. Broken concrete or asphalt pavement shall not be acceptable for use in the work.
- d. Riprap and grout colors may be limited by local flood control districts or other regulatory entities. Contractor is responsible for ascertaining and complying with any such requirements.

B. Geotextile:

1. Geotextile shall be Class 2 Non-Woven in accordance with AASHTO M288 with an AOS of 70.
- C. Sand Cushion:
1. Sand cushion shall be clean sand, free of angular gravel.
- D. Grout:
1. Concrete for the grout shall be an approved batch meeting the following requirements:
    - a. All concrete shall develop 3,000 psi compressive strength within 28 days, the cement shall be Type II modified or Type V, the stone aggregate shall have a maximum diameter of ½", and the slump shall be within a range of 3 to 6 inches.
    - b. The water/cement ratio shall not exceed 0.48.
    - c. Add 1.5 lbs of synthetic fiber-reinforcing per cy of grout per manufacturer's instructions.
- E. Synthetic Fiber-Reinforcing:
1. 100 percent virgin polypropylene, fibrillated fibers containing no reprocessed olefin materials and specifically manufactured for use in concrete.
  2. Physical characteristics:
    - a. Specific gravity: 0.91.
    - b. Fiber length: ¾".
    - c. Provide in accordance with ASTM C1116.
    - d. Acceptable manufacturers:
      - 1) Fibermesh.
      - 2) Grace Construction Products.

## 2.02 SOURCE QUALITY CONTROL

- A. Perform all tests at an approved independent laboratory.
- B. Obtain samples in conformance with COE CRD-C100.
- C. Source Tests:
  1. Supply certified tests and service records to determine acceptability and application of stone materials.

2. In event suitable test reports or a service record that is satisfactory are not available, as in case of newly operated sources, subject material to tests necessary to determine its acceptability for use.
  3. Tests to which materials to be subjected include:
    - a. Specific gravity.
    - b. Soundness in magnesium sulfate.
    - c. Soundness in freezing and thawing.
- D. Material Acceptability Tests:
1. Initial test: On material from each ledge sampled prior to start of construction.
    - a. Specific gravity.
    - b. Soundness in magnesium sulfate.
    - c. Soundness in freezing and thawing.
  2. Control tests:
    - a. Perform control tests including one specific gravity, one soundness in magnesium sulfate, and one soundness in freezing and thawing for each type of stone revetment material for every 100 tons of material.
- E. Specific Gravity Test:
1. Conform with ASTM C127.
  2. Not less than 2.40 minimum.
- F. Soundness in Magnesium Sulfate:
1. Conform with ASTM C88, except maintain samples immersed in solution at a temperature of 80° F (26° C) +2° F.
  2. Not more than 12 percent loss at five cycles.
- G. Soundness of Aggregates in Freezing and Thawing:
1. Conform with AASHTO T103 method as modified herein.
  2. Ensure loss at 12 cycles of not more than 10 percent.
  3. Maintain temperature of cold liquid in range of -5 to 0 deg. F (-20 to -18 deg. C).

4. Maintain thaw fluid temperature in range of 45 to 50 deg. F (7 to 10 deg. C).
5. Permit length of freezing and of thawing cycles of 2 hours with 1 hour of freezing following by 1 hour of thawing.
6. Perform thawing by circulating thaw fluid around pan containing stone immersed in a depth of 1/4" rather than by total immersion.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Trim and dress all areas to required cross sections.
- B. Bring areas that are below allowable minus tolerance limit to grade by filling with material similar to adjacent material.
- C. Compact base to density specified for backfill in accordance with Section 31 20 00.
- D. Do not place any stone material on prepared base prior to inspection by Engineer.

### **3.02 PLACING**

- A. Ungrouted Riprap:
  1. Where indicated on Drawings, place geotextile on prepared foundation within limits indicated.
    - a. Geotextile overlaps shall be a minimum of 1' – 0".
    - b. Geotextile shall be secured to slope per the manufacturer's recommendation.
  2. Where indicated on Drawings, place sand cushion on geotextile within limits indicated.
    - a. Sand cushion shall have a minimum thickness of 4 inches.
  3. Place stone revetment material on prepared base within limits indicated.
  4. Place on prepared base to produce a well-graded mass of stone with minimum percentage of voids.
  5. Place to required thickness and grades.
  6. Place to full thickness in a single operation to avoid displacing the underlying material.

7. Distribute entire mass to conform to gradation specified.
    - a. Do not place stone by dumping into chutes or by similar method likely to cause segregation.
  8. Keep finished stone revetment free from objectionable pockets of small stones or clusters of larger stone.
    - a. Hand place as necessary to obtain a well-graded distribution.
  9. Ensure a final tolerance of within 3 inches from indicated slope and grade lines.
  10. Place stone revetment in conjunction with embankment construction to prevent mixture of embankment and stone revetment materials.
  11. Maintain stone revetment until accepted.
  12. Replace any displaced material to lines and grades shown.
- B. Grouted Riprap:
1. The Contractor must notify the SCRRA a minimum of two working days of his intent to perform any grouting activities prior to placement of any grout to allow scheduling of inspection activities. Grout operation shall not proceed without the approval of the SCRRA.
  2. Contractor must clean with a water blast operation faces and edges of any existing to-remain structural elements such as wingwalls or abutments to which the grouted riprap will come in contact.
  3. Riprap shall be placed prior to grouting. It is desirable that elongated stones along the top layer of riprap have a vertical orientation.
  4. Dewatering shall be implemented to guarantee that the grout will not be placed in water or be exposed to stream flows for a period of 24 hours after the grout has been placed.
  5. Contractor must keep riprap, boulders and concrete walls that are to receive grout wet at all times prior to injecting grout.
  6. The concrete grout shall be placed by injection methods by pumping under low pressure, positive displacement methods, through a 2 inches maximum diameter hose to ensure complete penetration of the grout into the rock layer.
  7. The voids at the surface of the riprap will not be grouted. The depth of grout measured from the prepared subgrade bed shall be 18 inches. Operator shall be able to stop the flow of grout when required, and will place grout in the voids and not on the surface of the riprap.



8. A "pencil" vibrator will be used to make sure all voids are filled between and under the riprap. The intent is to fill all voids from the subgrade level around the riprap for a minimum depth of 18 inches. In all cases, grout must penetrate to the subgrade of the riprap. The pencil vibrator may be used to smooth the appearance of the surface, but the Contractor must use a wood float to smooth and grade the grout to drain. When placing grout, it shall be placed between the riprap and against earth, rock, or concrete excavated sidewalls.
9. Contractor must clean and wash any spillage before the grout sets. The visible surfaces of the riprap will be free of grout to provide a clean natural appearance.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

#### **A. UngROUTed Riprap:**

1. UngROUTed riprap of the various classifications 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. Grouted Riprap:**

1. Grouted riprap of the various gradations 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. UngROUTed Riprap:**

1. UngROUTed riprap 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.

2. The contract price paid unit of ungrouted riprap for each classification shall include compensation to the Contractor for furnishing riprap, all labor, materials, equipment and any other incidentals to place riprap complete-in-place, including haul from the suppliers source, necessary stockpiling at the job site, reloading for placement, placement, overestimates of salvageable boulders, disposing of any rejected riprap, excavation and removal of material, over-excavation for construction, backfilling, and any other miscellaneous items and work shown or reasonable implied on the Plans, in the Specifications for this work, and elsewhere in the Contract Documents.
3. Geotextile and sand base and other associated materials and incidentals and installation thereof shall be considered part of the riprap and full compensation therefore shall be considered as included in the contract unit price paid for ungrouted riprap.

B. Grouted Riprap:

1. Grouted riprap 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.
2. The contract price paid per unit of grouted riprap for each classification shall include compensation to the Contractor for furnishing riprap, all labor, materials, equipment and any other incidentals to place riprap complete-in-place, including haul from the suppliers source, necessary stockpiling at the job site, reloading for placement, placement, overestimates of salvageable boulders, disposing of any rejected riprap, excavation and removal of material, over-excavation for construction, backfilling, and any other miscellaneous items and work shown or reasonable implied on the Plans, in the Specifications for this work, and elsewhere in the Contract Documents.
3. Geotextile and sand base and other associated materials and incidentals and installation thereof shall be considered part of the riprap and full compensation therefore shall be considered as included in the contract unit price paid for grouted riprap.

**END OF SECTION 34 80 11**

## **SECTION 34 80 21**

### **PILING**

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

##### **1.01 SUMMARY**

- A. Section Includes:
  - 1. Driven piling indicated in the Contract Documents.
- B. Description:
  - 1. Piles:
    - a. These Specifications shall govern the furnishing, driving, building up and cutting off of steel pipe piles and sheet piles in accordance with the lines, grades, and locations shown on the plans or as directed by the Engineer.
  - 2. Settlement of embankment fill shall be substantially complete prior to the driving of piling unless otherwise shown on the plans.
  - 3. Foundation piling shall not be driven until the excavation is complete.
- C. Related Specifications 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 Concrete.
  - 5. Section 31 20 00 - Earthwork.
  - 6. Section 34 80 43 - Precast and Prestressed Concrete for Railroad Bridges.

##### **1.02 REFERENCES**

- A. American Institute of Steel Construction (AISC):
  - 1. Manual of Steel Construction.
- B. ASTM International (ASTM):

1. A36, Standard Specification for Carbon Structure Steel.
  2. A252, Standard Specification for Welded and Seamless Steel Pipe Piles.
  3. A328, Standard Specification for Steel Sheet Piling.
- C. American Welding Society (AWS):
1. D1.5, Bridge Welding Code.
- D. American Railway Engineering and Maintenance-of-Way Association (AREMA):
1. AREMA Manual for Railway Engineering.
- E. Southern California Railroad Authority (SCRRA) Standards.
- F. In case of conflict between SCRRA Standards and AREMA , SCRRA Standards takes precedence; use in lieu of conflicting portions.

### 1.03 DEFINITIONS

- A. Certified Welder: Meeting the qualification requirements of AWS D1.5.
- B. Welding Procedure Specification: AWS D1.5.

### 1.04 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. Steel pile type, size, dimensions and grade of steel.
    - b. Pile tip protection/closure device.
    - c. Manufacturer and type of pile splicing device.
    - d. Load test equipment description with calibration charts.
- B. The Contractor shall provide to the Engineer a description of all pile driving equipment to be employed in the work, prior to commencement of pile installation. This shall include details including weights of pile hammer, power plant, leads, pile cushion, cap block and helmet.
- C. The Contractor shall visit the site and review the Geotechnical Report and test borings prior to selecting the pile driving hammer.

- D. The Contractor shall provide to the Engineer Plans demonstrating compliance of driving equipment and steel casing with Contract Documents. Plans shall include shop and erection details, casing details, and enclosures, splices, driving helmets, and reinforcement.
- E. The Contractor shall perform and submit the results of wave equation analysis for proposed installation equipment and piling material.
  - 1. Calculations shall be performed and sealed by a Professional Civil Engineer licensed in the State of California.
  - 2. Pile compressive stresses must be limited to allowable values during installation in accordance with the AREMA Manual for Railway Engineering, Chapter 8, Part 4.
  - 3. The results of the wave equation analysis shall demonstrate that the pile stresses are higher at the top of the pile compared to the tip, that the piles can achieve the required penetration into the hard strata without damaging the pile, and that an excessive number of blows per foot are not needed to achieve the required penetration and capacities.
  - 4. The recommended pile driving criteria for the driving of piles (chart with bearing as a function of ram fall and blow count) shall be submitted for review.
- F. Welder's certification and Welding Procedure Specification (WPS).
- G. Pile reports shall be submitted by the Contractor to the Engineer within 3 days of completion of driving. The pile record shall be completed per Article 3.11 of these specifications.
- H. As-built pile location Drawing(s):
  - 1. Sealed by licensed land surveyor registered in the State of California.
  - 2. Include deviations beyond acceptable tolerances from specified locations.

### **1.05 QUALITY ASSURANCE**

- A. Qualifications:
  - 1. Welders and welding processes to be qualified in accordance with AWS D1.5 requirements.
    - a. Welders to have been qualified during the 12 month period prior to commencement of welding.

### **1.06 PROJECT CONDITIONS**

- A. Do not begin pile installation until the earthwork in the area where piles are to be driven has been completed, to the extent possible, as shown in the Contract Documents.

- B. Jetting or predrilling of piling will not be permitted unless shown on the plans.
- C. The use of followers shall only be permissible if driving pile through the existing bridge deck.
  - 1. If followers are used, their use shall be incorporated into the Contractor's wave equation analysis.
- D. All work shall comply with these Specifications, the AREMA Manual for Railway Engineering, and the SCRAA standards.

## **PART 2 - PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Submit pile manufacturer information to the Engineer for review and approval prior to ordering and fabricating material.

### **2.02 MATERIALS**

- A. Timber Piles:

- 1. Timber piles shall be in accordance with Chapter 7, Part I, Article 1.9 of the AREMA Manual for Railway Engineering for first-class piles with a minimum tip circumference of 25 inches.
- 2. If preservative treatment is specified in the special provisions or on the plans, it shall be in accordance with Chapter 3, Part 6 of the AREMA Manual for Railway Engineering.
- 3. The method of storing and handling timber piles shall be such as to avoid damage to the piles. Piles shall be handled with hemp or synthetic fiber slings or wire rope encased in rubber hose, taking care to avoid dropping, bruising, breaking or penetrating the outer fibers.

- B. Steel Piles:

- 1. Steel Bearing Piles: Steel bearing piles shall be of the section shown on the plans and shall be structural steel, containing no less than 0.2 percent copper, conforming to ASTM A572, Grade 50, or ASTM A588. Piles shall not be painted before driving.
- 2. Steel Sheet Piles: Steel sheet piles shall be of the section and length shown on the plans and shall conform to ASTM A328 unless otherwise shown on the plans.

C. Steel Pipe Piles:

1. Steel pipe piles shall be of the outside diameter and wall thickness shown on the plans and shall conform to ASTM A252, Grade 2 or 3 for piles less than 14 inches in diameter and shall conform to ASTM A252 Grade 3 for piles 14 inches and greater in diameter unless other material is specified on the plans. Piles shall have an end treatment as shown on the plans. Piles shall not be painted before driving.
2. All concrete materials and reinforcing steel and their preparation and placement, used in filling steel pipe piles, shall be in accordance with Section 03 31 00 and Section 03 21 00. All concrete shall have a minimum compressive strength equal to that shown on the plans.

D. Storing and Handling:

1. Piles to be stored shall be placed on skids above ground and a sufficient number used to prevent visible deflection in the stored piles. Piles shall be kept clean and fully drained at all times. The method of handling shall be such that no damage will result to the piles.

## 2.03 CONCRETE PILES

A. Precast:

1. Precast concrete piles shall be of the type, size and length shown on the plans.
2. All concrete materials and steel reinforcing and their preparation and placement shall be in accordance with Section 03 31 00 and Section 03 21 00. All concrete shall have a minimum compressive strength equal to that shown on the plans.

B. Prestressed:

1. Prestressed concrete piles shall meet the requirements, and shall be of the type, size, and length shown on the plans, manufactured in accordance with Section 03 31 00 and Section 03 21 00.

C. Defects and Breakage:

1. Piles cracked in the process of curing, handling or driving, which in the opinion of the Engineer can be satisfactorily repaired, shall be repaired at the Contractor's expense and under the direction of the Engineer. If repair is not possible in the opinion of the Engineer, the piles shall be replaced at the Contractor's expense.

D. Storing and Handling:

1. The method of storing and handling piles shall be such as to minimize the danger of fracture by impact or undue bending stresses. Unless otherwise

provided, piles shall be handled by means of a suitable bridle or sling attached to the pile at the pick-up points marked on the pile. Use of rubberized cables is also acceptable. The use of chain slings will not be permitted.

2. Piles shall be stored above ground on adequate blocking located within 1 foot of the pick-up points marked on the pile that will prevent undue stresses in the piles. When piles are only partially supported during hauling, the overhang shall not exceed the lengths permitted for pick-up. If piles are stacked for storage, blocking for all layers shall be in the same vertical plane.

#### **2.04 PILE CAPACITY**

- A. The driven compressive capacity of piles shall be equal or greater than the allowable working compressive load capacity, if provided and as stated on the Contract Plans.

#### **2.05 FABRICATION**

- A. Ends of piles to be machine cut and square making an angle of 90 degrees with the longitudinal axis of the pile.
- B. Tolerances:
  1. HP piles: Conform to requirements for "HP" shapes as indicated in AISC Manual of Steel Construction.

### **PART 3 - EXECUTION**

#### **3.01 INSPECTION**

- A. Such services shall be arranged and contracted by the Contractor.
- B. Payment to be included in the lump sum price.

#### **3.02 LINES AND LEVELS**

- A. Complete necessary excavation and furnish lines and levels as required to install piles at their indicated locations.

#### **3.03 DRIVING PILES**

- A. Driving Equipment:
  1. Piles shall be driven with air, hydraulic or diesel powered hammers approved by the Engineer prior to use. The use of drop hammers will not be permitted. The use of steam hammers are not permitted unless approved by the SCRRA. The weight of the ram of the hammer shall not exceed 7000 lbs unless approved in writing by the Engineer. The hammer to be used shall have the approval of the Engineer. Steel sheet piles and



steel H piles may be driven with vibratory hammers if approved by the Engineer.

2. The hammer shall be operated at all times at pressures and speeds recommended by the manufacturer. If steam or air hammers are used, air compressor capacity shall be adequate to maintain full rated pressure throughout the driving period of any pile. The air compressor shall be equipped with an accurate pressure gage at all times.
3. Pile drivers shall be equipped with leads which are constructed in such a manner as to afford freedom of movement of the hammer and to provide adequate support of the pile during driving. The longitudinal axis of the leads and hammer shall coincide with the longitudinal axis of the pile. Except where piles are driven through water, the leads shall be long enough so that a follower will not be necessary. Where a follower is required for driving piles underwater, one pile in each group of ten shall be long enough to permit driving without a follower. This pile shall be used as a test pile for proper correlation of the follower-driven piles bearing capacity. This pile shall be paid for as a permanent pile and not as a "test pile."

B. Driving Tolerances:

1. Piles for bent construction shall be driven with a degree of accuracy that will permit framing into bents with a minimum of pulling or jacking. Under ordinary conditions, pipe piles, after driving and before framing, shall not vary from the vertical or from the required batter by more than 1/8 inches per foot of pile above finished ground, except that under ordinary conditions, the maximum deviation of the top of the pile from the plan location shall be 2 inches in the direction of the structure centerline and 4 inches in the direction along the centerline of the bend.
2. Foundation piles shall be driven to the vertical or batter line shown on the plans and the top of the completed pile shall not be more than 4 inches in any direction from the position shown on the plans. The center of gravity of the completed pile group shall not vary by more than 3 inches from the center of gravity determined from plan location.
3. If necessary to meet the required tolerances, pilot holes or guide templates may be used. Generally, the diameter of pilot hole shall be as specified in Article 3.03.F.1.

C. Protection of Pile Heads:

1. A steel driving head suitable for the type and size of piles being driven shall be used. Steel bearing piles and steel sheet piles shall be driven with a driving head compatible with the specific pile shape driven.

2. For concrete piles, a cushion block shall be provided between the driving head and the top of the pile. Wood cushion blocks, wire rope mat, belting, or other suitable material shall be used, subject to the approval of the Engineer, to prevent damage to the pile. Cushion blocks shall be changed as necessary to maintain an effective cushion.

D. Pile Damage and Misalignment:

1. Care shall be exercised to avoid damage to piles from overdriving. Any pile that is damaged to the extent that it will not perform its design function; any pile that is driven off location or alignment beyond the allowable tolerances; or cut off below ground line. The Contractor shall cease driving and as directed by the Engineer. If the defective pile condition is due to Contractor's negligence, the cost of replacement and redriving shall be borne by the Contractor.

E. Pile Penetration:

1. All piles shall be driven to a penetration as required by these specifications. The length of the piles shown on the plans is the length which is estimated to give the minimum required penetration and bearing.
2. When test piles are required by the contract, the pile lengths and penetration required will be established by the Engineer on the basis of the test pile data. These lengths and elevation of pile tips shall supersede requirements shown on the plans.
3. Unless otherwise shown on the plans or directed in writing by the Engineer for cases where piles penetrate into competent rock, foundation piles shall be driven to a penetration of a minimum 10 feet below bottom of footing, and other piles to a penetration of at least 15 feet below natural or finished ground line, whichever is lower.
4. When the specified penetration cannot be obtained without overdriving the piles, the Contractor shall provide either pilot holes or jetting equipment or a combination of both.

F. Pilot Holes:

1. If piles cannot be driven to the required penetration and the material is not suitable for jetting, the Engineer may permit pilot holes to be drilled to facilitate driving. The Engineer will designate the diameter and depth of the drilled hole. Ordinarily, a drill diameter of 12 inches will be satisfactory for timber piles and typically a drill diameter 4 inches less than the diagonal of square piles, 2 inches less than the diagonal of octagonal piles, and 1 inch less than the diameter of round piles will be satisfactory for steel pipe and concrete piles.

2. Where pilot holes are required in granular material which cannot be sealed off by ordinary "mudding" drilling methods, a casing pipe of sufficient diameter shall be placed around the boring device. The casing shall be of sufficient length to extend through the loose materials and shall be held in position until the pilot hole is completed and the pile placed ready for driving.
3. If the hard material extends below the desired penetration, the drilling shall be stopped 1 foot above that level and the pile driven the remaining distance if it is possible to do so without damaging the pile. If the pile does not completely fill the pilot hole, the space between the pile and the wall of the hole shall be filled with dry granular material prior to driving as directed by the Engineer.
4. Pilot holes shall be considered as incidental to piles and no direct payment will be made for this work.

G. Jetting:

1. If piles cannot be driven to the required penetration and the material is not suitable for pilot holes, the Engineer may permit jetting to facilitate drilling.
2. For jetting operations sufficient power shall be provided, in addition to that used for operating the hammer, to supply water volume and pressure sufficient to freely erode the material adjacent to the pile.
3. Jetting shall be stopped a minimum of 2 feet above the desired tip elevation and the final penetration obtained by driving without jetting. In silty soils it is possible that jetting may loosen the soil around piles already driven. If such a condition is considered possible, piles shall be redriven after all jetting within 25 feet has been completed.
4. Jetting shall be considered as incidental to piles, and no direct payment will be made for this work.

H. Shooting Pilot Holes:

1. The use of explosives for drilling of pilot holes will not be permitted.

I. Bearing Capacity:

1. All piles shall be driven to the allowable working compressive load specified on the plans, in the special provisions, or by the Engineer. The bearing values shall be determined using the following formula unless otherwise shown on the plans:

$$P = \frac{3eE}{s + c} \times \frac{W_r + n^2W}{W_r + W_p}$$

P = Allowable working compressive load (lbs) (based on factor of safety of 4.0)

e = Hammer efficiency = 0.6 to 0.9 (varies with hammer type and condition)

E = Hammer energy per blow =  $W_r \times h$  for single acting steam or air hammer or open cylinder Diesel hammer

s = Penetration of pile per hammer blow (inches/blow)

c = Average temporary compression (inches) = 0.1

$W_r$  = Weight of ram of hammer (lbs)

h = Hammer ram stroke (feet) average during 1 inch of pile penetration

n = Coefficient of restitution = 0.65 to 0.9 (varies with material and hammer)

$W_p$  = Weight being driven (pounds) includes pile and pile follower, anvil, drive cap and adapter as applicable

2. When measuring penetration per blow to determine if adequate bearing capacity has been obtained, the hammer shall be running freely and at the speed specified by the manufacturer for full rated energy output.
3. If, for some unavoidable reason, driving must be interrupted before final penetration is reached, the penetration per blow to determine bearing capacity shall not be measured until 12 inches of penetration or refusal has been obtained after driving has been resumed.

J. Pile Driving Near Fresh Concrete:

1. Piles shall not be driven within 150 feet of concrete that was placed within the previous 24 hours. If piling are driven within 150 feet of concrete that has not attained its specified 28-day strength, the following distances, based on the concrete strength and pile hammer rated energy, shall be maintained between the concrete and the nearest pile.

### 3.04 TEST PILES

- A. The furnished length of test piles shall be a minimum of 10 feet longer than the estimated length of the permanent piles shown on the plans or as directed by the Engineer.
- B. Wherever possible, test piles shall be driven in a location as shown on the plans. If not so used in the permanent structure, test piles shall be cut off at least 3 feet below final grate or extracted as directed by the Engineer. Extraction of test piles shall be considered incidental to the test pile item, and no separate compensation will be made for this work.
- C. Ground elevations shall be brought to finished grade wherever possible prior to driving test piles, so that the test pile will be comparable to the piles used in the permanent structure.

- D. Equipment used for driving test piles shall be adequate for handling the lengths provided without splicing. The hammer and all accessories used shall be the same make and model as that to be used in driving the permanent piles.
- E. Driving of a test pile shall continue until a penetration and bearing capacity is obtained as indicated by these specifications. Typically, test piles shall be driven to not less than 125 percent of the ultimate pile capacity required for permanent piles in the bridge structure.

### 3.05 TIMBER PILES

#### A. Pile Preparation:

- 1. When the furnished length is much longer than the required length, the Engineer may permit shortening the tip end before driving so as to have the desired diameter at the cut-off.
- 2. Pile tips shall be cut perpendicular to the axis of the pile.
- 3. The piles for bents shall be matched as much as possible in diameter to facilitate framing and bracing.

#### B. Cut-offs:

- 1. Piles which are to be encased in concrete shall be cut-off square with a saw to the elevation shown on the plan or established by the Engineer. The pile heads shall then be swabbed with preservative as specified on the contract documents.
- 2. Piles which are to support steel or timber caps shall be brought into final position and held while cut-off is made. Any chains or jacks used in positioning the piles shall be arranged so that the surface of the pile below cut-off will not be damaged. Cut-off shall be made with a saw to a true plane and to the exact elevation shown on the plans so that the cap will bear on the entire cross section of each pile in the bent. No shims will be permitted between the pile and the cap. Piles must show a solid head at the plane of cutting, and after cut-off, the pile caps shall be protected with preservative, fabric, and plastic cement as specified on the contract documents.
- 3. Cut-off portions of piles furnished by SCRRA remain the property of SCRRA, and shall be hauled to and loaded into rail cars by the Contractor. In the event rail cars are not available, the cut-offs will be stockpiled at a location designated by the Engineer. Stubs under 5 feet in length shall be disposed of by the Contractor in accordance with all applicable environmental laws and regulations. No extra payment will be allowed for this work.

#### C. Treatment of Damaged Surfaces:

1. Any pile surface below cut-off that has been scuffed, torn or otherwise damaged shall be treated in accordance with the requirements of the applicable plans.

### **3.06 STEEL BEARING PILES AND STEEL SHEET PILES**

#### **A. Splices and Build-ups:**

1. The length of steel bearing piles and steel sheet piles shown on the plans may be built up in sections either before or during driving operations. The sections, unless otherwise shown on the plans, shall be of identical cross-section. Pile splices shall be made by full penetration butt welding the entire cross-section or as otherwise shown on the plans. All welding shall be in accordance with AWS D1.5. Care shall be taken to properly align the sections connected so that the axis of the pile will be straight. Pile splices above a point 15 feet below finished ground line shall be reinforced as shown on the plans, unless otherwise directed by the Engineer. Field splices shall be avoided for lengths under 60 feet. No more than two (2) splices will be permitted on each pile.

#### **B. Cut-Offs:**

1. Piles shall be cut off, with a cutting torch, or by other acceptable methods, to the elevation shown on the plans. Where caps are required, piles shall be brought into final position and held while cut off is made and the end surface of the piles shall be made as smooth as practicable with maximum gap of 1/8 inches between pile and pile cap.

### **3.07 STEEL PIPE PILES**

#### **A. Splices and Build-ups:**

1. The length of a steel pipe pile may be built up in sections either before or during the driving operation. The minimum length of a section measured between welded splices shall be 5 feet, and between drive splices shall be 30 feet. Only one welded splice and no drive splices will be permitted in that portion of the pile exposed above ground line or normal water line. Drive splices shall be 15 feet below the ground line, unless directed by the Engineer.
2. Care shall be taken to properly align the sections to be spliced to insure a straight axis. The sections shall be spliced together in accordance with details shown on the plans. All welding shall be in accordance with the AWS D1.5.

#### **B. Cut-Offs:**

1. Piles shall be cut off, with a cutting torch, or by other acceptable methods, to the elevation shown on the plans or established by the Engineer. Where caps are required, piles shall be brought into final position and held while cut off is made and the end surface of the piles shall be made as smooth as practicable with maximum gap of 1/8 inches between pile and pile cap.

C. Placement of Concrete:

1. After all driving, splicing, and positioning of pile is completed, the pile shall be free from buckles, splits, distortions, water or other foreign matter. The Contractor shall provide equipment, lighting, and facilities necessary for the proper inspection of the piles. Any damaged, improperly driven, or otherwise defective pile shall be removed and replaced at the Contractor's expense.
2. The tops of piles shall be kept covered after driving until the concrete is placed. No concrete shall be placed in the piles in any unit until the driving of all piles in that unit has been completed. No concrete shall be placed until the Engineer has inspected the completed pile and reinforcing steel, when required, and given his approval to proceed. Unit is defined as a pier, bent or abutment.
3. Concrete shall be placed in a continuous operation taking care to prevent segregation. Special placing devices shall be used if necessary.

### 3.08 PRECAST AND PRESTRESSED CONCRETE PILES

A. Splices:

1. Splices for precast and prestressed concrete piles will not be permitted.

B. Build-ups:

1. Build-ups shall be made in accordance with the details shown on the plans. The concrete used for the build-up shall be of the same quality as that used originally in the pile. Just prior to placing the concrete, the top of the pile shall be coated with an epoxy bonding compound approved by the Engineer.
2. When additional driving of precast non-prestressed piles is required, the built-up portion shall obtain a compressive strength equal to the design compressive strength of the original pile prior to redriving.

C. Cut-Offs:

1. Concrete at the end of a pile terminating in cast-in-place concrete shall be cut back the required amount leaving the reinforcing steel or prestressing steel exposed. The final cut of the concrete shall be normal to the axis of the pile. Any damage to the pile below the plan cut-off elevation shall be remedied by further cut-back and built-up.

### 3.09 OBSTRUCTIONS

- A. Should any obstruction including but not limited to boulders, rocks, rubble, fill, existing foundations or timbers be encountered which prevent driving of pile to its required tip elevation or final driving resistance, threaten pile damage or cause pile to drift from required location horizontally or vertically, cease driving and take corrective action as directed by Engineer.

### 3.10 DAMAGED PILES

- A. Replace damaged piles as directed by the Engineer at no additional expense to the SCRRA.
- B. Each pile to be free from defects and damage due to construction, fabrication, delivery, installation or other causes.
- C. Damaged piles include but not necessarily limited to piles bent, buckled, cracked, with fabrication tolerances beyond those indicated, or with any other defect as determined by the Engineer that would weaken the pile.
- D. Should any pile as determined by the Engineer be damaged, be too short to develop required final driving resistance or to reach required tip elevation or otherwise not conform to this Specification Section, withdraw pile and drive another pile in its place.
  - 1. If it is impossible to withdraw damaged or rejected pile, install another pile at location indicated by the Engineer.
  - 2. Revise foundation as directed by the Engineer as required by new location of pile.
  - 3. Additional pile and foundation to be at the Contractor's expense.
- E. Correct to satisfaction of Engineer at no additional cost to the SCRRA any pile or other construction that has been damaged by pile installation.

### 3.11 PILE REPORT

- A. Provide Engineer with a copy of a pile report for all driven pile providing the following information:
  - 1. Pile location and number.
  - 2. Date and time driven.
  - 3. Weather.
  - 4. Hammer (manufacturer, model, and serial number).
  - 5. Hammer cushion and cap block.
  - 6. Pile type.



7. Batter.
8. Length of pile (tip to cut off).
9. Description of piles that were rejected (pile number, location, reason for rejection).
10. Cut off elevation.
11. Pile tip elevation.
12. Ground elevation.
13. Length spliced on.
14. Length furnished.
15. Length cut off.
16. Hammer blow count and ram fall for each foot along full length of pile.
  - a. Penetration of last foot of driving in blows per inch.
17. Final driving resistance and calculated bearing.
18. Stroke or hammer speed at final resistance.
19. Name of person recording information
20. Pile driving record (shown at the end of the specifications).

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

#### **A. Piles**

1. General:
  - a. Piles delivered of the various kinds, sizes, types, and weights will be measured by the lineal foot, except steel sheet piles will be measured by the square foot, of acceptable pile delivered at the site of work and furnished in accordance with the lengths specified on the plans.
  - b. Piles driven of the various kinds, sizes, types, and weights will be measured to the nearest 1/10 lineal foot of net length of pile in place, except steel sheet piles will be measured by the square foot of acceptable pile in place, after all cut-offs and build-ups have been made.

- c. That portion of piles driven below the elevation required by the plans and piles driven below the elevation at which the minimum penetration and bearing requirements were first obtained will not be measured for payment.
  - d. Determination of installed pile lengths:
    - 1) Estimated lengths of steel piling shown on the Contract Plans shall be considered as approximate only and as having been determined for design and estimating purposes from the test borings taken at the site.
    - 2) The Contractor shall be entirely responsible for furnishing piles of sufficient lengths to obtain the required penetration and specified bearing for each pile.
2. Timber Piles:
- a. Piles supplied by the SCRRA which fail during driving, due to an inherent weakness in the pile and not due to negligence on the part of the Contractor, and which are extracted or cut-off at the direction of the Engineer, will be measured for payment by the lineal foot of pile in the leads. Piles supplied by the SCRRA and broken during driving due to Contractor's negligence will not be measured for payment. Piles supplied by the Contractor and broken during driving will not be measured for payment.
  - b. Cut-off portions of piles will not be measured for payment.
3. Steel Piles: Cut-off portions of piles will not be measured for payment.
4. Concrete Piles, Precast and Prestressed:
- a. 2 feet will be added to the length of piles, measured for payment in accordance with Paragraph 1.07.A.1. for each authorized build-up made, other than those made necessary by improper casting, handling or driving of piles.
  - b. Cut-off portions of piles, when piles are supplied by the Contractor in the lengths shown on the plans or ordered by the Engineer, will be measured by the lineal foot of cut-off above design elevation. Cutbacks made below design elevation for the purpose of making build-ups will be considered incidental to the work and will not be measured.
  - c. When piles of extra length are furnished to eliminate protrusion of reinforcing steel required for splicing, such extra length will not be measured for payment as either piles or cut-off portion of piles.

B. Test Piles

1. Test piles of the various kinds, sizes, types and weights, when the piles do not become a part of the permanent structure, will be measured by the lineal foot of pile in the leads and driven in accordance with these specifications and in the location specified on the plans or by the Engineer. When test piles becomes a part of the permanent structure, they will be measured by the lineal foot of acceptable pile in place after all cut-offs and build-ups have been made in accordance with the provisions of Paragraph 1.07.A covering the various kinds of piles.

C. Reinforced Pile Tips

1. Reinforced pile tips will be measured by the number of reinforced tips installed on steel bearing piles and driven in place.

#### 4.02 PAYMENT

A. Piles

1. Piles Delivered:

- a. Piles delivered will be paid for at the contract unit price per lineal foot or square foot, as designated in Article 4.01, of the various kinds, sizes, types, and weights.

- 1) The contract unit price shall include full compensation for all work and costs involved for furnishing the piles, unless otherwise specified; unloading, storing, and transporting the piles. This price shall not include compensation for concrete or reinforcing steel in steel pipe piles which will be paid for under Section 34 80 41 and Section 34 80 42.

2. Piles Driven:

- a. Piles driven will be paid for at the contract unit price per lineal foot or square foot, as designated in Article 4.01, of the various kinds, sizes, types, and weights.

- 1) The contract unit price shall include full compensation for furnishing all labor, materials, tools, equipment, jetting, pilot holes, and incidentals necessary to drive and cut-off the piles and complete the work. The Contractor shall accept the contingencies of driving greater or lesser length of piles or other changes of features in construction which this may involve, all without modification of the unit price fixed by the Contract.

3. Timber Piles:

- a. The contract price per lineal foot of acceptable timber pile shall also include full compensation for preparing the piles, disposing of the pile heads, treating the pile tops as specified in Paragraph 3.05.B.

and the treating of damaged surfaces, splits, and checks as specified in Paragraph 3.05.B.

4. Splices for Steel Bearing Piles and Steel Pipe Piles:

- a. Payment for the work and materials, exclusive of additional length of pile, required in making each pile splice shall be made at a unit price per splice equal to two times the unit price bid for "Steel Bearing Piles Driven" or "Steel Pipe Piles Driven," as applies, of the size and weight on which the splice is made except that no payment will be made for any splice on any pile whose actual length left in place, after all cut-offs, splices, or build-ups have been made, is not greater than the length shown on the plans or specified by the Engineer, nor will payment be made for more than one splice on anyone pile less than 120 feet long.

5. Steel Sheet Piles:

- a. No direct payment will be made for cut-off portions of piles.

6. Concrete Piles, Precast and Prestressed:

- a. Cut-off portions of piles, measured in accordance with Paragraph 4.01.A.4.b., will be paid for at one half the unit price bid per lineal foot for concrete piles.

B. Test Piles

1. Test piles will be paid for at the contract unit price per lineal foot of test pile of the various kinds, sizes, types, and weights.

- a. The contract unit price shall include full compensation for furnishing the piles, unless otherwise specified; unloading, storing, and transporting the piles; and for furnishing all labor, materials, tools, equipment, jetting, pilot holes, and incidentals necessary to drive the piles and complete the work. Payment will be made for splices authorized by the Engineer at the rate specified in Paragraph 4.02.A.4.

C. Reinforced Pile Tips

1. Payment for reinforced pile tips on steel bearing piles, if required, shall be made at the contract unit price per each.

- a. The contract unit price shall include full compensation for furnishing all material, labor and equipment required to install the tips. Payment will be made only for reinforced tips required as shown on the plans or as requested by the Engineer.

**PILE DRIVING RECORD**

PROJECT _____	DATE _____
PILE NO. _____	LOCATION _____

CONTRACTOR _____
FOREMAN _____
OBSERVER _____

GROUND ELEVATION _____
PILE TIP ELEVATION _____
CUTOFF ELEVATION _____
PILE TYPE/SIZE _____
LENGTH _____
BATTER _____

HAMMER TYPE/SIZE _____
CAP/HELMET/CUSION _____
RAM WEIGHT _____
THROTTLE SETTING _____

Depth ft	Blows foot	Stroke	Depth ft	Blows foot	Stroke	Depth ft	Blows foot	Stroke	Depth ft	Blows foot	Stroke
0-1			25-26			50-51			75-76		
1-2			26-27			51-52			76-77		
2-3			27-28			52-53			77-78		
3-4			28-29			53-54			78-79		
4-5			29-30			54-55			79-80		
5-6			30-31			55-56			80-81		
6-7			31-32			56-57			81-82		
7-8			32-33			57-58			82-83		
8-9			33-34			58-59			83-84		
9-10			34-35			59-60			84-85		
10-11			35-36			60-61			85-86		
11-12			36-37			61-62			86-87		
12-13			37-38			62-63			87-88		
13-14			38-39			63-64			88-89		
14-15			39-40			64-65			89-90		
15-16			40-41			65-66			90-91		
16-17			41-42			66-67			91-92		
17-18			42-43			67-68			92-93		
18-19			43-44			68-69			93-94		
19-20			44-45			69-70			94-95		
20-21			45-46			70-71			95-96		
21-22			46-47			71-72			96-97		
22-23			47-48			72-73			97-98		
23-24			48-49			73-74			98-99		
24-25			49-50			74-75			99-100		

REMARKS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

TIME OF START \_\_\_\_\_ TIME OF STOP \_\_\_\_\_

**END OF SECTION 34 80 21**

## SECTION 34 80 22

### CAST-IN-DRILLED HOLE (CIDH) PILES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Construction of CIDH pile foundations.
- 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 Concrete.
- C. CIDH Pile construction shall be in accordance with the most current edition of The American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual of Railway Engineering, Chapter 8: Concrete Structures and Foundations, Part 24: Drilled Shaft Foundations.

##### 1.02 REFERENCES

- A. ADSC West Coast Chapter, Standard CIDH Pile Anomaly Mitigation Plan “A” and Plan “B”.
- B. American Railway Engineering and Maintenance-of-Way Association (AREMA).
  - 1. Manual for Railway Engineering.
- C. American National Standards Institute (ANSI):
  - 1. A135.4 – Basic Hardboard Standards
- D. ASTM International (ASTM):
  - 1. A36, Standard Specification for Carbon Structural Steel.
  - 2. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 3. A252, Standard Specification for welded and Seamless Steel Pipe Piles.

4. A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
  5. A929, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process for Corrugated Steel Pipe.
  6. C203, Standard Test Method for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
  7. D1751, Standard Specifications for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
  8. D4380, Standard Test Method for Density of Bentonitic Slurries.
  9. D4381, Standard Test Method for Sand Content by Volume of Bentonitic Slurries.
  10. D4972, Standard Test Method for pH of Soils.
- E. American Petroleum Institute (API):
1. RP 138-1, Standard Procedure for Field Testing Water-Based Drilling Fluids.
- F. American Welding Society (AWS):
1. D1.1, Structural Welding Code - Steel.
- G. California Department of Transportation (Caltrans):
1. Soil and Rock Logging, Classification, and Presentation Manula (2010 Edition).
  2. California Test 233, Method of Ascertaining the Homogeneity of Concrete in Cast-In-Drilled-Hole (CIDH) Piles Using the Gamma-Gamma Test Method.

### 1.03 SUBMITTALS

- A. See Division 01 for requirements for the mechanics and administration of the submittal process.
- B. Log of installation of all CIDH Piles.
- C. Shop Drawings of all reinforcing and accessories required for the CIDH Piles.
- D. Product Technical Data including:
  1. Acknowledgement that products meet the requirements of the standards referenced.

2. Proposed concrete mix design for the CIDH Piles:
  - a. See Section 03 31 00 for information to be included in the mix design submittal.
- E. Test Reports:
  1. Copies of concrete strength tests for concrete placed in the CIDH Piles.
- F. Contractors qualifications as specified in Article 1.02.B. in this Specification Section.
- G. CIDH Pile installation plan as specified in Article 3.02.A. in this Specification Section.
- H. Slurry test results as specified in Article 2.01.A. in this Specification Section.
- I. AWS Welder Certification.

#### **1.04 QUALITY ASSURANCE**

- A. Qualifications:
  1. Contractor Qualifications:
    - a. Two (2) weeks prior to the pre-construction conference, the Contractor must submit the contractor's qualification as specified in the following to Engineer.
    - b. Unless otherwise indicated, the minimum Contractor's experience shall consist of successful installation of at least 5 CIDH Pile Projects of similar or greater size, and similar geotechnical conditions installed within the past 3 years.
      - 1) The mentioned documentation shall reference and detail the size of the CIDH piles, methods used during installation, methods used for stabilizing the CIDH pile wall excavations, local soil conditions, actual construction time, contract time, names and phone numbers of owner's representatives who can verify the Contractor's participation on those projects.
      - 2) The Contractor must provide documentation of their superintendent's qualifications, record experience, and prior project references demonstrating that they can handle unusual site conditions and equipment breakdowns.



- c. The CIDH pile work shall be performed under the supervision of the Contractor's superintendent, who shall be fully knowledgeable and experienced in construction of CIDH pile foundations of similar size and geotechnical conditions as those shown on the plans.
  - 1) In addition, the Contractor's superintendent performing the work shall have at least 5 years of experience installing similar size CIDH piles within the last 8 years.
  - 2) The Engineer may accept or reject the Contractor's CIDH Pile Subcontractor and its superintendent based on their qualifications and previous field performance.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

- A. Slurry:
  - 1. Only mineral or polymer slurries shall be used in the drilling process unless other drilling fluids are approved in writing by the Engineer.
  - 2. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement.
  - 3. In the event of a sudden significant loss of slurry to the excavation, the construction of the foundation shall be stopped until either methods to stop slurry loss or an alternate construction procedure has been approved by the Engineer.
  - 4. All tests specified below shall be performed when the slurry temperature is above 40° F.
  - 5. Mineral slurry or polymer slurry shall be premixed thoroughly with clean, fresh water, and adequate time (as prescribed by the manufacturer) allotted for hydration in slurry tanks.
    - a. Slurry tanks of adequate capacity will be required for slurry circulation, storage, treatment, and disposal.
    - b. No excavated slurry pits will be allowed.
    - c. The Contractor must draw sample sets from the slurry tanks and test the samples for conformance with the specified material properties prior to introduction into the shaft excavation.
    - d. A sample set shall be composed of samples taken at mid-height and within 2 feet of the bottom of the slurry tanks.

6. The Contractor must sample and test all slurry in the presence of the Engineer, unless otherwise directed.
  - a. The date, time, names of the persons sampling and testing the slurry, and the results of the tests shall be recorded.
  - b. A copy of the recorded slurry test results shall be submitted to the Engineer at the completion of each pile, and during construction of each pile when requested by the Engineer.
7. Sample sets of all slurry, composed of samples taken at mid-height and within 2 feet of the bottom of the pile, shall be taken and tested during shaft excavation as necessary to verify the control of the properties of the slurry.
  - a. As a minimum, sample sets shall be taken and tested at least once every 2 hours after beginning slurry use.
  - b. When the test results show consistent specified properties, sample sets shall be taken and tested at least once every 4 hours of slurry use.
  - c. Slurry shall be recirculated, or agitated with the drilling equipment, when tests show that the sample sets do not have consistent specified properties.
8. When samples are found to be unacceptable, the Contractor must clean, recirculate, desand, or replace the slurry to maintain the required slurry properties.
  - a. Cleaning of the bottom of the excavation and placement of the concrete shall not begin until tests show that the sample sets have consistent specified properties.
9. The Contractor must demonstrate to the satisfaction of the Engineer that stable conditions are being maintained.
  - a. If the Engineer determines that stable conditions are not being maintained, the Contractor must immediately take action to stabilize the shaft.
  - b. The Contractor must submit a revised installation plan, which corrects the problem and prevents future instability.
  - c. The Contractor shall not continue with pile construction until receiving the Engineer's approval of the revised pile installation plan.
10. Controlled Slurry:

- a. Slurry shall consist of a stable colloidal suspension of various pulverized clays or polymers thoroughly mixed with water with the properties given in the Required Slurry Property Table below.
- b. Water used to mix slurry shall be potable.

<b>REQUIRED SLURRY PROPERTIES TABLE</b>		
<b>Items to be measured</b>	<b>Range of results at 60° F</b>	<b>Test Methods</b>
1. Density before concrete placement, lb/ft <sup>3</sup> for slurry 1 foot from shaft bottom		(Mud Balance) ASTM D4380
Mineral slurries (bentonite/attopulgite)		
a. No end bearing	85 maximum	
b. With end bearing	70 maximum	
Polymer slurry		
a. No end bearing	64 maximum	
b. With end bearing	64 maximum	
2. Marsh funnel viscosity, sec/qt, for entry		
a. Mineral slurries (bentonite/attopulgite)	26 to 50	
b. Polymer slurry	40 to 90*	
	* or as recommended by manufacturer and approved by SCRRA	
3. Sand content by volume, percent, before concrete placement for slurry 1 foot from shaft bottom		(Sand screen set) ASTM D4381
Mineral slurries (bentonite/attopulgite)		
a. No end bearing	4 maximum	
b. With end bearing	20 maximum	
Polymer slurry		
a. No end bearing	1 maximum	

<b>REQUIRED SLURRY PROPERTIES TABLE</b>		
b. With end bearing	1 maximum	
4. pH, during excavation	7 to 12	ASTM D4972

c. The Contractor must wait 30 minutes, after the last drilling and scouring, to allow contaminants to settle out before taking and testing a sample set of slurry.

1) After the reinforcing steel cage is placed in the excavation, a sample set of slurry shall be taken and tested immediately prior to concrete placement.

**B. Concrete:**

1. All materials, proportioning, air entraining, mixing, slump, and transporting of PCC shall be in accordance with Section 03 31 00 except as modified herein.
2. The water/cement ratio shall not exceed 0.45.
3. The concrete for construction of drilled shafts shall have a slump of 8 inches  $\pm$ 1.5 inches.
4. Concrete admixtures:
  - a. Comply with Section 03 31 00.

**C. Reinforcing Steel:**

1. Provide reinforcing steel conforming to requirements of Section 03 21 00.
  - a. Reinforcing sizes, number, configuration, spacing and lengths to be as indicated on Plans.

**D. Steel Casing (Permanent and Temporary):**

1. Permanent steel casing shall have sufficient strength to withstand handling stresses, drilling and installation stresses, concrete pressures, and surrounding earth and water pressures, if required.
  - a. Steel for permanent casing shall conform to the requirements of ASTM A283: Grade C, ASTM A36, or ASTM A929.
  - b. Submit size, wall thickness, type of steel, and length of permanent casing to the SCRRA for acceptance.

2. Temporary steel casing shall have sufficient strength to withstand handling stresses, drilling and installation stresses, concrete pressures, and surrounding earth and water pressures, or if required, for protection of personnel or to permit advancement of shaft through caving ground.
    - a. Submit size, wall thickness, type of steel, and length of permanent casing to the SCRRA for acceptance.
  3. Furnish full-penetration welds meeting the requirements of "Structural Welding Code - Steel" (ANSI/AWS D1.1) of the American Welding Society requirements for joints in non-corrugated permanent steel casings.
    - a. Welders shall be AWS certified.
  4. Deliver casing to site in undamaged condition.
    - a. Handle and protect casing to maintain diameter within 2 percent.
- E. Expanded Polystyrene:
1. Expanded polystyrene must be commercially available polystyrene board with (1) a flexural strength of at least 35 psi when tested under ASTM C203 and (2) a compressive yield strength from 16 to 40 psi at 5 percent compression. Face the surfaces of expanded polystyrene that concrete is placed against with 1/8 IN thick hardboard complying with ANSI A135.4. Other facing materials may be used that provide equivalent protection. Secure the hardboard using nails, waterproof adhesive, or other authorized means.

### **PART 3 - EXECUTION**

#### **3.01 CONSTRUCTION AND TOLERANCES:**

- A. The CIDH Pile shall be within 3 inches of plan position at the top of shaft.
- B. The vertical alignment of pile excavation shall not vary from the plan alignment by more than 1/4 inches/feet.
- C. Full depth reinforcing steel cages shall be set at no less than 6 inches above the bottom of the excavated shaft prior to placement of concrete.
- D. After all the concrete is placed, the top of the reinforcing steel cage shall be no more than six (6) Inch above and no more than 2-3/4 inches below plan position.
- E. The top elevation of the shaft may have a tolerance of up to +1 inches or -3 inches from the plan top of pile elevation.
  1. Sufficient reinforcement bar splice length for splices above the shaft shall be attained.

- F. Excavation equipment and methods shall be designed so that the completed shaft excavation will have a planar bottom.
  - 1. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of 3/8 in/ft of diameter.
- G. CIDH Pile excavations and completed shafts not constructed within the required tolerances are unacceptable.
  - 1. The Contractor shall be responsible for correcting all unacceptable pile excavations and completed shafts to the satisfaction of the Engineer.
  - 2. Materials and work necessary, including engineering analysis and redesign, to complete corrections for out of tolerance CIDH pile excavations shall be furnished without either cost to the Contracting Authority or an extension of the completion dates of the project.
- H. The elevations, dimensions, and depth of the CIDH Piles shall be as specified on the Plans.
- I. The dimensions of casings are subject to American Pipe Institute tolerances applicable to regular steel pipe.

### **3.02 INSTALLATION**

- A. The installation of the CIDH pile must be done in a continuous operation with no unplanned interruptions. If an unplanned interruption cannot be avoided, the engineer shall be notified immediately and the contractor must submit remedial measures for approval.
- B. CIDH Pile Installation Plan:
  - 1. The Contractor must submit a signed statement that they have inspected the project site and all the subsurface information made available in the contract documents.
  - 2. No later than 1 month prior to constructing CIDH Piles, the Contractor must submit a CIDH Pile installation plan for review by the Engineer.
    - a. This plan shall provide information on the following:
      - 1) Name and experience record of firm(s) and associated personnel for the following:
        - a) Driller.
        - b) Drilled shaft superintendent.

- 2) List of proposed equipment to be used including cranes, drills, augers, bailing buckets, grooving equipment, scouring equipment, final cleaning equipment, core sampling equipment, confirmation boring equipment, tremies or concrete pumps, casing, slurry equipment, airlift pumps, etc.
- 3) Details of overall construction operation sequence, the sequence of pile construction in bents or groups and pile construction.
- 4) Details of pile excavation methods.
- 5) Details of steel casing and forms, including installation and extraction methods.
- 6) Details of the type and methods to mix, circulate, desand, test, and dispose of slurry (if applicable).
  - a) If polymer slurry is proposed, submit data on load transfer and manufacturers requirements for slurry control.
- 7) Details of methods to clean the pile excavation, including air lift methods and spin bucket methods as applicable.
- 8) Details of reinforcement placement including support and cage centering methods.
- 9) Reinforcing steel cage splicing method, if proposed, including details of dimensions, installation, splice location, support and cage centering methods, and estimated time required for splicing.
- 10) Details of concrete placement including procedures for tremie or pumping methods and method to prevent slurry intrusion at the discharge end.
- 11) Details of methods to control cuttings, water and slurry. with adjacent traffic conditions (vehicular or railroad if applicable).
- 12) Details of final discharge of concrete at top of pile, of removing contaminated concrete, and verifying concrete uniformity for site specific conditions.
- 13) Details on casing to be used, including specific length/depth of all casing proposed, and specific evaluation and determination of casing (size, depth, etc.) required to prevent any shaft installation procedure from having an effect or impact on adjacent structures, railroads, etc.

- 14) Details of casing being seated into rock to seal groundwater from entering the drill hole.
3. The Engineer will evaluate the CIDH pile installation plan for conformance with the Contract Documents.
    - a. Within 14 calendar days after receipt of the plan, the Engineer will notify the Contractor of additional information required and changes necessary to meet the Contract requirements.
    - b. All procedural approvals given by the Engineer shall be subject to trial in the field and shall not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed in the Contract Documents.
  4. A pre-drilling conference will be required for this work prior to the start of pile excavation. The Engineer and SCRRA will set up the conference.
    - a. The Engineer, Contractor, and drilling staff shall discuss the anticipated pile installation process.
- C. Pile Excavation:
1. Protection of Existing Structures:
    - a. Precautions shall be taken to prevent damage to existing structures and utilities.
    - b. These measures shall include but are not limited to vibration monitoring, or subsidence control during driving of casings, sheets, or drilling.
  2. Construction Method:
    - a. If the concrete is to be placed under the wet condition as defined in this Specification, the Contractor must construct CIDH piles in such a manner that the elevation of the water or slurry inside the pile will be equal to or higher than the ground water elevation at the time of concrete placement.
    - b. The CIDH Piles may be constructed by casing method to produce sound, durable concrete foundation shafts free of defects.
      - 1) Wet method may be combined with casing method with approval from the Engineer only if the excavation can not be dewatered and concrete placed in the dry, as defined elsewhere in this Specification Section.



- 2) Wet Method:
  - a) The wet method consists of keeping the shaft filled with slurry a minimum of 4 feet above the highest expected water table during drilling and excavation, desanding of the slurry when required, final cleaning of the excavation by means of a bailing bucket, air lift, pump or other approved device and placing shaft concrete which displaces the slurry.
- 3) Casing Method:
  - a) The casing method is used to advance the hole through unstable material.
    - (1) Undercutting to the outside diameter of the casing may be required.
  - b) The purpose of the steel casing is to stabilize the side walls during drilling to prevent cave-ins from unstable material and vibrations. The purpose of the casing is also to prevent any pile installation procedure from having an impact on adjacent structures and railroads.
  - c) If voids exist between the permanent casing and the drill hole, lean grout or a sand/gravel mix shall be placed as directed by the Engineer.
- c. Surface and subsurface obstructions shall be removed by the Contractor.
  - 1) Special tools and/or procedures may be required.
  - 2) No separate payment will be made for removing obstructions.
- d. Excavations required for the CIDH Piles shall be performed through whatever materials encountered, of the dimensions, and to the elevations shown in the Plans.
  - 1) The excavation and installation method shall be suitable for the intended results and materials are encountered.
  - 2) Blasting is not permitted.
3. Excavation in rock is defined as the excavation that cannot be drilled or accomplished with conventional augers designated to excavate hard soil or soft rock and that requires special tools and procedures to make the excavation advance.

- a. Rock drilling tools such as augers with fitted rock teeth, core barrel, buckets with significant down crowding, or roller bits combined with extra drilling pressure by a hydraulic or percussion system are used for the rock drilling excavation.
4. The Contractor shall anticipate and make available at the job site all equipment necessary and essential to penetrate soft and hard rock during the construction of the drilled shafts.
    - a. The equipment for excavation, drilling, and cleaning operations shall have adequate capacity; including power, torque, and down thrust to excavate a hole to an elevation equal to the lowest tip elevation of the production drilled shafts installed from the equipment operation elevation at the time of drilled shaft construction, plus 25 feet or plus 25 percent of the maximum length of the production drilled shafts, whichever is greater.
      - 1) The Contractor must have drilling tools available to increase diameter of shaft should initial drilled hole be out of vertical tolerances stated in this Specification.
  5. CIDH piles shall be installed in such a manner that no voids shall exist between the overburden and the casings.
  6. The drilling sequence shall be such that for every pile drilled, at least two piles are skipped. The piles adjacent to the freshly poured pile may only be drilled a minimum of 24 hours after placement of concrete.
  7. The Contractor must extend CIDH pile tip elevations if the Engineer determines that the material encountered during excavation or present at tip elevation is unsuitable and/or differs from that anticipated in the design of the CIDH pile.
  8. After the pile excavation has been completed, the Contractor shall immediately proceed with shaft construction.
  9. Safety:
    - a. The Contractor shall not permit any worker to enter the CIDH pile excavation for any reason unless; a suitable casing has been installed, the water level has been lowered and stabilized below the level to be occupied, and an adequate safety equipment and procedures have been provided to the personnel entering the excavation which includes OSHA certification for confined-entry-space.

## 10. Record Information:

- a. For each CIDH pile construction, the Contractor must provide the Engineer with an excavation record including but not limited to the following: the location; dimensions; verticality; description of the materials encountered at all elevations; drilling time in each of the various strata; elevation of the water table during excavation; description of any change in excavated material; elevation of top and bottom of the finished pile; depth to the steel casing; condition of the bottom of the excavation and deviation from plan location.
  - 1) All unusual observations shall be reported to the Engineer within 8 hours of discovery.
  - 2) Two (2) copies of the excavation records, signed by a responsible representative of the Contractor and cosigned by a representative of the Engineer, shall be furnished to the Engineer within one (1) day after the pile excavation is completed.
- b. The Contractor must retain additional CIDH pile installation records including, but not limited to the following: Concrete volume, concrete pouring rate, and other pertinent data to the CIDH pile operations.
  - 1) Copies of these installation records shall be submitted to the Engineer within one (1) day after the finish of the installation.

## D. Steel Casing (Temporary and Permanent):

1. The procedure and methods to install and seal the steel casings shall not produce stresses in excess of 25 percent over the design allowable for the type of steel used.
  - a. The Contractor must submit computations of critical stresses imposed on the steel casing during installation.
  - b. The casing shall not be more than one inch out of round before and after installation.
2. Welding of steel casings shall be by a semi-automatic or automatic welding process to fully develop the casing.
  - a. All welding shall be in accordance with ANSI/AWS D1.1.
3. Nondestructive testing of the welds will not be required; however, the Contractor shall be responsible for placing a sound, watertight casing.
4. After installation but prior to excavation of the rock socket, the casings shall be inspected for location, alignment and condition.

- a. Any casing that shows bends or kinks or other deformations that would impair the strength or efficiency of the complete shaft shall be either removed and replaced or repaired by the Contractor in a manner satisfactory to the Engineer.
  - b. Repairing or replacing casing when ordered by the Engineer shall be done at no additional cost to the Contracting Authority.
- E. Dewatering and Rock Socket:
1. The Contractor shall determine the elevation of the top of the rock and at the bottom of the casing at each drilled shaft location.
    - a. The method shall be approved by the Engineer, and the elevation determined during the presence of Engineer or the Engineer's representative.
  2. Prior to excavation of the rock socket, the Contractor shall seat the casing in the sound rock for a minimum depth of 1 foot and attempt to dewater the shaft.
    - a. If the shaft cannot be dewatered to the dry condition or the satisfaction of the Engineer, the Contractor shall attempt to seal the shaft by carrying the casing further into the rock.
    - b. This procedure shall be followed for each drilled shaft.
    - c. The Contractor will not be required to carry the casing more than an additional 3 feet (a total of 4 feet) into the sound rock. The casing may be advanced four feet into the sound rock during initial placement.
    - d. The preliminary tip elevations of the casings are shown in the plans based on available borings.
    - e. The actual elevation shall be determined based on actual rock elevation and conditions encountered during excavation as determined by the Contractor using the method(s) approved by and in the presence of the Engineer.
    - f. After the casing has been seated sufficiently to allow dewatering to achieve the dry condition or the satisfaction of the Engineer or to the maximum depth specified above, the Contractor shall excavate the rock socket.
      - 1) The aforementioned dry condition is defined as less than 12 inches of water accumulation above the base over a 1 hour period.



- b. If the amount of sediment meets the above requirements, the Contractor shall clean the base of the pile a second time with the air lift and immediately proceed with shaft construction.
- c. If after the described wait period the amount of sediment exceeds the requirements, the Contractor shall clean the pile by air lift and repeat the above procedure until the sediment accumulation meets the requirements.
- d. The Engineer may approve, at no additional cost to the SCRRA, an alternate method to clean the bottom of the pile.

G. Inspection of Shaft and Rock Socket

1. The Contractor must provide suitable means of access and lighting facilities for the Engineer to check locations, dimensions, and alignment of the casings, inspect conditions of the casings, and inspect and determine that the rock sockets are satisfactory.
  - a. Final shaft depths will be measured with a suitable weighted tape or other approved methods after final cleaning.
2. At all times when a person is in a dewatered casing, provision shall be made for pumping fresh air to said person; and any required lighting shall be by electric lights.
  - a. Any mechanical equipment used inside the casing shall be operated by air or electricity.
  - b. The use of gasoline engines or other types of equipment producing fumes placed in the excavation for pumping or drilling are not permitted.
3. If the shaft cannot be dewatered, the Contractor must provide a method for visual inspection to confirm that the shaft is in an acceptable condition and that rock socket cleanliness requirements are met.

H. Reinforcing Steel Cage Construction and Placement:

1. The reinforcing steel cage consisting of longitudinal bars, ties, cage stiffener bars, spacers, cage centering devices, and other necessary appurtenances, shall be completely assembled and placed immediately after the pile excavation is inspected and accepted, and prior to concrete placement.
2. The reinforcing steel in the pile shall be tied and supported so that the reinforcing steel will remain within allowable tolerances given in this Specification Section.
  - a. Reinforcing added to stiffen a reinforcing cage will be at the Contractor's expense and as approved by the Engineer.

- b. Concrete spacers or other approved non-corrosive spacing devices shall be used at sufficient intervals, near the top and bottom and at intervals not exceeding 10 feet along the shaft, to ensure concentric spacing for the entire cage length.
          - c. Spacers shall be constructed of approved material equal in quality and durability to the concrete specified for the pile.
          - d. The spacers shall be of adequate dimension to ensure a minimum distance of 3 inches or as shown in the plan which ever is greater between the cage and the excavated hole.
          - e. When a full depth reinforcing steel cage is used, it shall be supported at the bottom by approved cylindrical feet to ensure that the bottom of the cage is maintained at the proper distance above the base.
  3. The elevation of the top of the steel cage shall be checked before and after the concrete is placed.
    - a. If the reinforcing cage is not maintained within the specified tolerances, corrections shall be made by the Contractor to the satisfaction of the Engineer.
    - b. No additional piles shall be constructed until the Contractor has modified the reinforcing cage support in a manner satisfactory to the Engineer.
  4. At no time shall the reinforcing cage be allowed to rest at the bottom of the drill hole.
- I. Concrete Placement:
1. Placement of concrete pile:
    - a. Concrete shall be placed as soon as possible after reinforcing steel placement.
    - b. The Contractor shall coordinate batching and delivery of the concrete with the batch plant so that the time limits, as stated in the Standard Specifications, between batching and delivery are not exceeded.
    - c. Concrete placement shall be continuous.
    - d. Concrete placement shall continue after the pile excavation is full until good quality concrete is evident at the top of shaft.
    - e. Remove a sufficient volume of concrete to ensure elimination of all contaminated concrete at the top of shaft using small pumps.

- f. Concrete shall be placed either through a tremie or concrete pump.
2. Placement of Concrete by Tremie:
    - a. The tremie used to deposit concrete shall be constructed so that it is watertight and will readily discharge concrete.
    - b. The tremie shall not be less than 10 in dia., and there shall be no aluminum parts in contact with concrete.
    - c. The discharge end of the tremie shall be constructed to prevent water or slurry intrusion and permit the free flow of concrete during placement operations.
    - d. The tremie shall have sufficient mass that it will rest on the pile bottom before start of concrete placement.
    - e. The length of the tremie shall be sufficient to extend to the bottom of the pile.
    - f. The discharge orifice shall be maintained between 5 feet and 10 feet below the surface of the fluid concrete.
    - g. The tremie shall be supported so that it can be raised to increase the discharge of concrete and lowered to reduce the discharge of concrete.
    - h. The flow of the concrete shall be continuous and the concrete in the tremie shall maintain a positive pressure differential at all times to prevent introduction of air pockets or contaminants into the concrete.
  3. Placement of Concrete by Pump:
    - a. Concrete pumps and lines may be used for concrete placement.
    - b. All pump lines shall have a minimum 4 inches dia. and be constructed with watertight joints.
      - 1) Concrete placement shall not begin until the pump line discharge orifice is at the pile base elevation.
    - c. A plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins.
      - 1) The plug shall either be removed from the excavation or be of a material, approved by the Engineer, which will not be a detriment to the pile if not removed.
    - d. The discharge orifice shall be maintained between 5 feet and 10 feet below the surface of the fluid concrete.



- 1) When lifting the pump line during concreting, the Contractor shall temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation.
- e. The pumping operation shall be performed in a manner that prevents introduction of air pockets into the concrete.
  - 1) If breaking of the pump line is required, the discharge orifice shall be temporarily positioned 3 feet to 5 feet below the surface of the fluid concrete in the hole.
  - 2) Additional methods to eliminate introduction of air into the concrete may be proposed by the Contractor.
4. The elapsed time from the beginning of concrete placement in the pile to the completion of the placement shall not exceed 3 hours.
  - a. All admixtures, when approved for use, shall be adjusted for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the 3 hours placement limit.
  - b. The Contractor may propose placement time over 3 hours provided the Contractor submits trial mix documentation that all concrete in the pile will retain a minimum 4 inches slump for the entire placement period.
- J. The concrete in the rock socket shall be, if at all possible, placed in the dry.
  1. The Contractor will be required to make a diligent effort to dewater the rock socket.
  2. If, after making such effort, it is determined by the Engineer that it is not possible to dewater the socket sufficiently to allow the concrete to be placed in the dry; the Contractor, with the Engineer's written approval, shall proceed with the placement of the concrete under water.
- K. The casing segment above the top elevation of the drilled shaft shall be left empty.
- L. Installation of Expanded Polystyrene
  1. Place expanded polystyrene in position before placing concrete.

### **3.03 TEMPORARY CASING WITHDRAWAL**

- A. Provide means and opportunity for the Engineer to inspect the operation during the withdrawal of casing and placing of concrete.
- B. Coordinate casing withdrawal carefully with concrete placement.

1. Maintain head of concrete to exceed the anticipated outside soil and water pressure above the bottom of the casing at all times during casing withdrawal.
- C. Check concrete level prior to, during, and after withdrawing casing to confirm that separation of shaft concrete has not occurred.
1. Do not vibrate concrete internally before the casing is withdrawn.
  2. A casing vibratory extractor is permitted.
  3. Do not withdraw casing after concrete has attained initial set as determined by the Engineer.

### **3.04 FIELD QUALITY CONTROL**

- A. Inspection of Pile:
1. For piles that have been dewatered, or constructed in the “Dry”, the Contractor shall provide a method for visual inspection to confirm that the pile is acceptable.
- B. Acceptance Testing of Pile:
1. For piles constructed by the “wet” or “slurry-displacement” method, the contractor shall provide acceptance testing by a qualified independent testing firm.
    - a. Contractor must submit qualifications of proposed testing firm for review and approval by the Engineer at least 14 days prior to the planned start of construction.
    - b. Testing firm shall have conducted acceptance testing of CIDH piles in similar circumstances and using the same test methods on at least 5 projects in the last 3 years.
  2. Vertical inspection pipes for acceptance testing shall be provided in all CIDH concrete piling constructed by the “wet” or “slurry displacement” methods.

3. The furnishing and placing of inspection pipes shall conform to the following:
  - a. Inspection pipes shall be Schedule 40 PVC pipe with a nominal inside diameter of 2 IN. Watertight PVC couplers are permitted to facilitate pipe lengths in excess of those which are commercially available. The Contractor shall log the location of the inspection pipe couplers with respect to the plane of pile cut off, and these logs shall be delivered to the Engineer upon completion of the placement of concrete in the drilled hole.
  - b. Each inspection pipe shall be capped at the bottom and shall extend from 3 FT above the pile cutoff down to the bottom of the reinforcing cage. A temporary top cap or similar means shall be provided to keep the pipes clean before testing. If pile cutoff is below the ground surface or working platform, inspection pipes shall be extended to 3 FT above the ground surface or working platform. Approved covers or railings shall be provided and inspection pipes shall be located as necessary to minimize exposure of testing personnel to potential falling hazards.
  - c. Inspection pipes shall be completely clean, dry, and unobstructed at the time of testing providing a 2 IN DIA clear opening.
  - d. The inspection pipes shall be installed in straight vertical alignment, parallel to the main reinforcement, and securely fastened in place to prevent misalignment during installation of the reinforcement and placing of concrete in the hole. The CIDH concrete piling shall be constructed so that the relative distance of inspection pipes to vertical steel reinforcement shall remain constant.
  - e. When any changes are made to the tip of CIDH concrete piling, the Contractor shall also extend the inspection pipes to the bottom of the reinforcing cage.
  - f. Inspection pipes shall be placed radially around the pile, inside the outermost spiral or hoop reinforcement and no more than 1 IN clear of the outermost spiral or hoop reinforcement.
  - g. Inspection pipes shall be placed around the pile at a uniform spacing not exceeding 33 IN measured along the circle passing through the centers of inspection pipes. A minimum of four (4) inspection pipes per pile shall be used. Inspection pipes shall be placed to provide the maximum diameter circle that passes through the centers of the inspection pipes while maintaining the spacing required herein.



6. Acceptance tests of the concrete shall be made by a qualified technician employed by the approved testing firm. Acceptance tests will evaluate the homogeneity of the placed concrete. Tests will include gamma-gamma logging (GGL) conducted in conformance with California Test 233. The Contractor shall not conduct operations within 25 FT of the gamma-gamma logging operations. The Contractor shall separate reinforcing steel as necessary to allow the technician access to the inspection pipes to perform gamma-gamma logging or other acceptance testing. After requesting acceptance tests and providing access to the piles, the Contractor shall allow 7 days for the technician to conduct these tests. The testing firm shall submit acceptance test results and interpretations to the Engineer no later than 7 days after completion of testing for each shaft.
7. The Engineer will make determination of acceptance after receiving test results. No superimposed construction shall proceed without acceptance of the CIDH pile by the Engineer.
8. The Engineer may elect to require additional tests to further evaluate a pile. These tests may include cross-hole sonic logging (CSL) and other means of inspection selected by the Engineer. When the Engineer elects to require additional tests to further evaluate anomalies for a rejected pile, no time requirement exists for performing these tests. The Contractor may progress with the mitigation plan process without waiting for these supplemental results.
9. Inspection pipes and cored holes shall be dewatered and filled with grout after notification by the Engineer that the pile is acceptable. Inspection pipes and holes shall be filled using grout tubes that extend to the bottom of the pipe or hole or into the grout already placed.
10. If the Engineer determines that a pile does not meet the requirements of the specifications and California Test 233, Part 5C, then that pile will be rejected and all depositing of concrete under slurry or concrete placed using temporary casing for the purpose of controlling groundwater shall be suspended until written changes to the methods of pile construction are approved in writing by the Engineer.

C. Mitigation of Rejected Pile:

1. The Engineer will determine whether the rejected pile requires mitigation due to structural, geotechnical, or corrosion concerns. The Engineer will consider the estimated size and location of the anomaly and potential effects upon the design. The Engineer will provide the conclusions of this analysis to the Contractor for development of a mitigation plan, if required. The Contractor shall allow 35 days for the Engineer to determine whether the pile requires mitigation and provide information to the Contractor. Day 1 of the 35 days shall be the 1st day after results of acceptance testing have been provided to the Engineer. If additional information is submitted to the Engineer that modifies the size, shape, or nature of the anomaly, the Contractor shall allow 15 additional days for the subsequent analysis.

2. If the Engineer determines that a rejected pile requires mitigation, the Contractor shall submit to the Engineer for approval a mitigation plan for repair, supplementation, or replacement for each rejected CIDH concrete pile. If the Engineer determines that it is not feasible to repair the rejected pile, the Contractor shall not include repair as a means of mitigation and shall proceed with the submittal of a mitigation plan for replacement or supplementation of the rejected pile.
3. Pile mitigation plans shall include the following:
  - a. The designation and location of the pile addressed by the mitigation plan.
  - b. A review of the structural, geotechnical, and corrosion design requirements of the rejected pile.
  - c. A step by step description of the mitigation work to be performed, including plans if necessary.
  - d. An assessment of how the proposed mitigation work will address the structural, geotechnical, and corrosion design requirements of the rejected pile.
  - e. Methods for preservation or restoration of existing earthen materials.
  - f. A list of affected facilities, if any, with methods and equipment for protection of these facilities during mitigation.
  - g. The assigned contract number, full name of the structure as shown on the contract plans, and the Contractor's (and Subcontractor's if applicable) name on each sheet.
  - h. A list of materials, with quantity estimates, and personnel, with qualifications, to be used to perform the mitigation work.
  - i. The seal and signature of an engineer who is licensed as a Civil Engineer by the State of California. This requirement is waived for approved mitigation plans when either of the following conditions are present:
    - 1) The proposed mitigation will be performed in conformance with the most recent version of "ADSC Standard Mitigation Plan 'A' - Basic Repair" without exception or modification.
    - 2) The Engineer has determined that the rejected pile does not require mitigation due to structural, geotechnical, or corrosion concerns, and the Contractor elects to repair the pile using the most recent version of the "ADSC Standard Mitigation Plan 'B' - Grouting Repair" without exception or modification.

- D. The most recent version of the "ADSC Standard Mitigation Plan" is available at: <http://www.dot.ca.gov/hq/esc/geotech/ft/adscmitplan.htm>
1. For rejected piles to be repaired, the Contractor shall submit a pile mitigation plan that contains the following additional information:
    - a. An assessment of the nature and size of the anomalies in the rejected pile.
    - b. Provisions for additional pile testing if required by the Engineer.
  2. For rejected piles to be replaced or supplemented, the Contractor shall submit a pile mitigation plan that contains the following additional information:
    - a. The proposed location and size of additional piles.
    - b. Structural details and calculations for any modification to the structure to accommodate the replacement or supplemental piles.
  3. All provisions for CIDH concrete piling shall apply to replacement piles.
  4. The Contractor shall allow the Engineer 20 days to review the mitigation plan after a complete submittal has been received.
  5. When repairs are performed, the Contractor shall submit a mitigation report to the Engineer within 10 days of completion of the repair. This report shall state exactly what repair work was performed and quantify the success of the repairs relative to the submitted mitigation plan. The mitigation report shall be stamped and signed by an engineer that is licensed as a Civil Engineer by the State of California. The mitigation report shall show the assigned contract number, full name of the structure as shown on the contract plans, and the Contractor (and subcontractor if applicable) name on each sheet. The Engineer will be the sole judge as to whether a mitigation proposal is acceptable, the mitigation efforts are successful, and to whether additional repairs, removal and replacement, or construction of a supplemental foundation is required.

### 3.05 CLEANING

- A. Control and Disposal of Materials:
1. Disposal of excavated material, as well as slurry and/or water removed from the shaft excavation, shall be the responsibility of the Contractor.
  2. All slurry and water, displaced during final cleaning and concrete placement, shall be collected and properly disposed off site.
  3. Open pits for collection of materials will not be allowed.

4. All excavated material, slurry, water, and other matter shall be controlled by the Contractor so that at no time it enters or encroaches upon the adjacent travel lanes, railroad and water ways.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. CIDH Piles 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. The length of each CIDH Piles to be paid for shall be the length, measured along the longest side, from the tip elevation shown on the plans, or the tip elevation ordered by the Engineer for the diameter of the pile shown on the plans, to the plane of the pile cut-off. No reduction in the length for payment will be made for any CIDH pile where the tip elevation is revised in conjunction with a request by the Contractor to increase the pile diameter.
- C. Reinforcing Steel 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 Reinforcing Steel.

### **4.02 PAYMENT**

- A. CIDH Piles will be paid the contract unit price, as listed in the Schedule of Quantities and Prices.
- B. The contract unit price shall include full compensation for all equipment, labor and materials necessary to satisfactorily construct the shafts; including drilling and excavation of shaft and rock socket, furnishing, installing and removing temporary casing, furnishing and placing concrete, confirmation boring and lab testing, reporting boring logs and lab test results, CSL (steel pipe) or gamma-gamma (PVC pipe) non-destructive testing and reporting, shaft inspection, disposal of excavated materials and water, and all other materials.
- C. Full compensation for furnishing all reinforcing steel in piles and pile extensions, including reinforcement required to extend beyond the pile or extension as shown on the Plans, shall be considered as included in the Contract price per unit for furnishing piling of the type or class shown in the Schedule of Quantities and Prices, and no additional compensation will be allowed therefor.

**END OF SECTION 34 80 22**



## SECTION 34 80 23

### SUBDRAINAGE SYSTEM FOR RAILROAD BRIDGES AND RETAINING WALLS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes Foundation Drainage System.
- 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.

##### 1.02 REFERENCES

- A. ASTM International (ASTM):
  - 1. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  - 2. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
  - 3. F405, Corrugated Polyethylene (PE) Tubing and Fittings.
  - 4. F667, Large Diameter Corrugated Polyethylene Pipe and Fittings.
  - 5. F758, Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.
  - 6. F949, Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.

##### 1.03 SYSTEM DESCRIPTION

- A. Extent: Furnish and install foundation drainage as a complete system as shown.
- B. Outlet Connections: Foundation pipe shall be terminated as shown on the Drawings.
- C. Drainage Lines: Construct drainage lines of perforated pipe.
- D. Outlet Line: Construct outlet lines of closed-joint non-perforated pipe.

**1.04 SUBMITTALS**

- A. See Division 01 for requirements for the mechanics and administration of the submittal process.
- B. Samples:
  - 1. Materials:
    - a. Two randomly selected samples of each type of pipe and fitting, prior to delivery of materials to the site.
- C. Certificates:
  - 1. Materials:
    - a. Certifications from the manufacturers attesting that materials meet Specification requirements.
    - b. Certifications are required for drain pipe, drain tile, fittings and filter fabric.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Delivery and Storage:
  - 1. Inspect materials delivered to site for damage; unload, and store with minimum handling.
  - 2. Do not store materials directly on the ground.
  - 3. The inside of pipes and fittings shall be free of dirt and debris.
  - 4. Install plastic pipe within 6 months from the date of manufacture unless otherwise approved.
- B. Handling:
  - 1. Handle materials in such a manner as to deliver to the trench in sound undamaged condition.
  - 2. Pipe shall be carried and not dragged to the trench.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- A. Plastic Pipe: Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

- B. Polyvinyl Chloride (PVC) Pipe: ASTM F758, Type PS 46, ASTM D3034, or ASTM F949 with a minimum pipe stiffness of 46 psi.
- C. Corrugated Polyethylene (PE) Pipe and Fittings:
1. Use ASTM F405 for pipes 3 to 6 inches in diameter inclusive, ASTM F667 for pipes 8 to 24 inches in diameter.
    - a. Fittings shall be manufacturer's standard pipe and shall conform to the indicated Specification.
- D. Pipe Perforations:
1. Water inlet area shall be a minimum of 0.5 SQ in/lf.
  2. Manufacturer's standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Engineer.
    - a. Circular Perforations in Plastic Pipe:
      - 1) Circular holes shall be cleanly cut not more than 3/8 inches or less than 3/16 inches in diameter and arranged in rows parallel to the longitudinal axis of the pipe.
      - 2) Perforations shall be approximately 3 inches OC along rows.
      - 3) The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows.
      - 4) The rows shall be spaced over not more than 155° of circumference.
      - 5) The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.
    - b. Slotted Perforations in Plastic Pipe:
      - 1) Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing.
      - 2) Width of slots shall not exceed 1/8 inches nor be less than 1/32 inches.
      - 3) The length of individual slots shall not exceed 1-1/4 inches on 3 inches dia. tubing, 10 percent of the tubing inside nominal circumference on 4 to 8 inches dia. tubing, and 2-1/2 inches on 10 inches dia. tubing.

- 4) Rows of slots shall be symmetrically spaced so that they are fully contained in 2 quadrants of the pipe.
  - 5) Slots shall be centered in the valleys of the corrugations of profile wall pipe.
- E. Fittings:
1. Fittings shall be of compatible materials for pipe, of corresponding weight and quality, and as specified herein.
- F. Bedding and Pervious Backfill for Foundation Drains:
1. Bedding and pervious backfill shall be in accordance with Section 31 20 00.
- G. Protective Covering for Pervious Backfill:
1. Protective covering shall be building paper.
- H. Filter Fabric:
1. Nonwoven polypropylene fabric.
  2. Not less than 4 oz/sy.
  3. Resistant to the chemical actions of the soil and water and non-biodegradable.
  4. Fabric to prevent the migration of soil particles into the subdrain while allowing the free flow of water from the subsoil to the subdrain pipe.
- I. Geocomposite Wall Drain:
1. Geocomposite wall drain shall consist of a manufactured core not less than 0.25 inches thick nor more than 2 inches thick with one or both sides covered with a layer of filter fabric.
    - a. The drain shall produce a flow rate of at least 2.0 gal per minute per foot of width at a hydraulic gradient of 1.0 and a minimum externally applied pressure of 3,500 psf.
  2. Filter Fabric for the geocomposite drain shall conform to the provisions for Filter Fabric in this Specification.
  3. The manufactured core shall be either a preformed grid of embossed plastic, a mat of random shapes of plastic fibers, a drainage net consisting of a uniform pattern of polymeric strands forming 2 sets of continuous flow channels, or a system of plastic pillars and interconnections forming a semirigid mat.

4. The core material and filter fabric shall be capable of maintaining a drainage void for the entire height of the geocomposite drain.
  - a. The filter fabric shall be integrally bonded to the core material.
  - b. Core material manufactured from impermeable plastic sheeting having non-connecting corrugations shall be placed with the corrugations approximately perpendicular to the drainage collection system.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Trenching and Excavation:
  1. Perform required trenching and excavation in accordance with Section 31 20 00.
    - a. Keep trenches dry during installation of drainage system.
    - b. Changes in direction of drain lines shall be made with 1/8 bends.
    - c. Use wye fittings at intersections.
- B. Bedding:
  1. Place graded bedding, minimum 6 inches in depth, in the bottom of trench for its full width and length compacted as specified prior to laying of foundation drain pipe.
  2. Each section shall rest firmly upon the bedding, through the entire length, with recesses formed for bell joints.
  3. Except for recesses for bell joints, the bedding shall fully support the lower quadrant of the pipe.
- C. Pipe Laying:
  1. Lay drain lines to true grades and alignment with a continuous fall in the direction of flow.
  2. Bells and grooves of pipe sections shall face upgrade.
  3. Clean interior of pipe thoroughly before being laid.
  4. When drain lines are left open for connection to discharge lines, the open ends shall be temporarily closed and the location marked with wooden stakes.
  5. Perforated pipe shall be laid with perforations facing down.

6. Any length that has had its grade or joints disturbed shall be removed and relaid at no additional cost to the SCRRA.
7. Perforated corrugated polyethylene drainage tubing and plastic piping shall be installed in accordance with Manufacturer's Specifications and as specified herein.
8. Tubing and piping with physical imperfections shall not be installed.

D. Jointing:

1. Perforated pipe:
  - a. Perforated types of drain pipes shall be laid with closed joints.
2. Non-perforated Drain Tile:
  - a. Non-perforated and plain-end drain tile shall be laid with 1/8" to 1/4" open joints.
  - b. Open joints shall be covered or wrapped.
  - c. Covered joints shall have one thickness of the cover material placed over the joint.
  - d. Material shall overlap the joint not less than 4 inches on each side and cover the tile for not less than the upper half or more than the upper two-thirds of the circumference of the tile.
  - e. Strips of wire cloth wrapping material 3 inches wide shall be used for wrapped joints, with ends fastened together.
3. PVC pipe:
  - a. PVC pipe joints shall be in accordance with ASTM D3034, ASTM D3212, or ASTM F949.
4. Perforated Corrugated Polyethylene Pipe:
  - a. Perforated corrugated polyethylene pipe shall be installed in accordance with Manufacturer's Specifications and specified herein.
  - b. No more than 5 percent stretch in a section will be permitted.

E. Outlet Lines:

1. The outlet end of drain lines connecting with an open gutter or outfall shall be covered with a removable wire basket of 16-mesh copper or bronze wire cloth fastened with brass or wire straps.

### 3.02 BACKFILLING

- A. After joints and connections have been inspected and approved, place the specified pervious backfill material a minimum width of 6 inches on each side of the pipe and 12 inches above the top of the pipe.
  - 1. Place the backfill preventing displacement of or injury to the pipe or tile.
  - 2. Place a protective covering, as specified in Section 31 20 00, over the pervious backfill for the full width of the trench before regular backfill is placed.
  - 3. Compact backfill as specified in Section 31 20 00.

### 3.03 TESTS

- A. Pipe Tests:
  - 1. Strength tests of pipe shall conform to field service test requirements of the ASTM Specification or AASHTO Specification covering the product (See paragraph 2.1. in this Specification Section).

## PART 4 - MEASUREMENT AND PAYMENT

### 4.01 MEASUREMENT

- A. Subdrainage System for Railroad Bridges, Retaining Walls, Concrete Masonry Wall, Concrete Retaining Wall, and Platforms 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. Subdrainage system for will be paid at the Contract lump sum price.
  - 1. The contract lump sum price paid for subdrainage system for Railroad Bridges, Retaining Walls, Concrete Masonry Wall, Concrete Retaining Wall, and Platforms shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the subdrainage system, complete in place, as shown on the Drawings, as specified in this Specification Section, and as directed by the Engineer.

2. Perforated drain pipe, non-perforated drain pipes, all connections and closures, joints, elbows, cleanouts and outlet hardware, concrete drainage swale or gutter, utility excavation and backfill and other associated material and incidentals and installation thereof will be considered part of the subdrainage system and full compensation therefore will be considered as included in the contract unit price paid for subdrainage system.

**END OF SECTION 34 80 23**



## SECTION 34 80 24

### AUGERCAST PILE HEADWALL AND WINGWALL

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Augercast pile headwall and wingwall.
- B. Description:
  - 1. This work shall consist of shaft excavation, backfilling shaft with lean concrete backfill, installing steel piling, installing steel brackets and steel support angles, installing precast concrete headwall and wingwall panels, connecting the culvert pipe to the headwall with end anchors, and backfilling the headwall and wingwall panels.
- C. 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 31 00 – Structural Concrete.
  - 4. Section 31 20 00 – Earthwork.
  - 5. Section 31 50 00 – Excavation Support.
  - 6. Section 33 42 00 – Culvert and Drainage Pipe.
  - 7. Section 34 80 43 – Precast and Prestressed Concrete for Railroad Bridges.
  - 8. Section 34 80 52 – Metal Fabrication for Railroad Bridges.
  - 9. Section 34 80 53 – Steel Handrails for Railroad Bridges.

##### 1.02 REFERENCES

- A. American Institute of Steel Construction (AISC):
  - 1. Manual of Steel Construction.
- B. American Society for Testing and Materials (ASTM):

1. A36, Standard Specification for Carbon Structure Steel.
  2. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
  3. A194, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
  4. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
- C. American Welding Society (AWS):
1. D1.1, Structural Welding Code, Steel.
- D. American Railway Engineering and Maintenance-of-Way Association (AREMA):
1. AREMA Manual for Railway Engineering, 2020.
- E. Southern California Railroad Authority (SCRRA) Standards, including:
1. Engineering Standard 6320:
    - a. Sheet 1 – Headwall and Wingwall Layout
    - b. Sheet 2 – Precast Concrete Headwall Details
    - c. Sheet 3 – Precast Concrete Wingwall Details
- F. State of California Department of Transportation Standard Specifications, 2018.
- G. In case of conflict between SCRRA Standards, AREMA, and State of California Department of Transportation SCRRA Standards takes precedence; use in lieu of conflicting portions.

### 1.03 SUBMITTALS

- A. Shop Drawings:
1. See Division 01 for requirements for the mechanics and administration of the submittal process.
  2. Shop drawings for the miscellaneous steel, in accordance with Section 34 80 52.
  3. Shop drawings for the precast concrete headwall and wingwall panels, in accordance with Section 34 80 43.
  4. Product technical data including:

- a. Steel pile type, size, dimensions and grade of steel.
  - b. Mix design for lean concrete backfill and socket concrete backfill.
  - c. End anchors.
  - d. Epoxy adhesive.
  - e. Grout.
- B. The Contractor shall provide to the Engineer a description of the augercast pile headwall and wingwall installation equipment to be employed in the work and sequence of installation, prior to commencement of the work.
- C. The Contractor shall provide details of shaft excavation methods including proposed drilling methods, methods for cleanout of the shafts, disposal plan for excavated material, temporary casing, if needed, and drilling slurry, if needed.
- D. The Contractor shall provide details of the method(s) to be used to ensure shaft stability (i.e., prevention of caving, bottom heave, etc. using temporary casing, slurry, or other means, or if soils are self-supporting) during excavation and concrete placement. If temporary casings are proposed, casing dimensions and detailed procedures for casing installation and removal shall be provided. If slurry is proposed, detailed procedures for mixing, using, maintaining, and disposing of the slurry shall be provided.
- E. If competent rock is expected, the Contractor shall provide details of temporary casing, rock boring equipment and pile socket installation.
- F. The Contractor shall provide details of soldier pile placement including internal support bracing and centralization methods.
- G. The Contractor shall provide details of lean concrete backfill or socket concrete backfill placement including proposed operational procedures for pumping and/or tremie methods.
- H. The Contractor shall provide its plan for shoring or sloping earth behind the augercast pile headwall and wingwall as necessary for construction in accordance with Section 31 50 00.
- I. Welder's certification and Welding Procedure Specification (WPS).
- J. Augercast pile installation reports shall be submitted by the Contractor to the Engineer within 3 days of completion of installation.

#### **1.04 QUALITY ASSURANCE**

- A. Qualifications:
1. Welders and welding processes to be qualified in accordance with AWS D1.1 requirements.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- A. Steel Piles:
  - 1. Steel piles for the augercast pile headwall and wingwall shall be of the section shown on the Contract Documents, containing no less than 0.2 percent copper, conforming to ASTM A572, Grade 50. Piles shall not be painted before installation.
- B. Miscellaneous Steel:
  - 1. Miscellaneous steel for use in the augercast pile headwall and wingwall shall be of the section shown on the Contract Documents, conforming to ASTM A36, including but not limited to the steel support brackets. Miscellaneous steel shall be painted as noted herein.
- C. Lean Concrete Backfill:
  - 1. Lean concrete backfill shall meet the requirements of Section 19-03.2I of the 2018 Caltrans Standard Specifications.
- D. Socket Concrete Backfill:
  - 1. Socket concrete backfill shall meet the requirements of Section 03 31 00 and Engineering Standard 6320, with a minimum compressive strength of 4,000 psi at 28 days.
- E. Precast Concrete Headwall and Wingwall Panels:
  - 1. Materials for the precast concrete headwall and wingwall panels shall meet the requirements of Section 34 80 43 and Engineering Standard 6320.
- F. Corrugated Metal Pipe (CMP) Culvert:
  - 1. Materials for corrugated metal pipe (CMP) culvert shall meet the requirements of Section 33 42 00.
- G. End Anchors:
  - 1. Threaded rods shall be galvanized and meet ASTM A193 Grade B7.
  - 2. Connecting nuts shall be galvanized and meet ASTM A194 Grade 2H.
- H. Epoxy Adhesive:
  - 1. Epoxy adhesive material shall be Hilti HIT-RE 500 V3 or approved equal.
- I. Grout:

1. Grout shall be cementitious and non-shrink, with a minimum compressive strength of 5,000 psi.
- J. Handrailing:
1. Handrailing and connecting materials shall meet the requirements of Section 34 80 53 and Engineering Standard 6320.

## 2.02 FABRICATION

- A. Steel Piles:
1. Ends of piles to be machine cut and square making an angle of 90 degrees with the longitudinal axis of the pile.
  2. Tolerances:
    - a. HP piles: Conform to requirements for "HP" shapes as indicated in AISC Manual of Steel Construction.
- B. Steel Support Brackets:
1. Steel support brackets shall be fabricated from angle sections, as noted on Engineering Standard 6320.
- C. Precast Concrete Wingwall Panels:
1. Fabrication of the precast concrete headwall and wingwall panels shall meet the requirements of Section 34 80 43.
- D. Corrugated Metal Pipe (CMP) Culvert:
1. Fabrication of the corrugated metal pipe (CMP) culvert shall meet the requirements of Section 33 42 00.
- E. Handrailing:
1. Fabrication of handrailing shall meet the requirements of Section 34 80 53.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Shaft Excavation:
1. Shafts shall be excavated to the required depth as shown in the Contract Documents. The minimum diameter of the shaft shall be as shown in the Contract Documents. The excavation shall be completed in a continuous operation using adequate equipment.

2. If rock, hard material or an obstruction is encountered prior to reaching the specified shaft tip elevation, the Contractor shall socket the shaft into the rock, hard material or through the obstruction in accordance with Engineering Standard 6320 and the Contract Documents.
3. Temporary casing, slurry, or other methods specified in the shaft installation plan as approved by the Engineer shall be used if necessary to ensure safety and stability.
4. No more than 12 inches of loose or disturbed material shall be present at the bottom of the shaft just prior to beginning concrete placement. The excavated shaft shall be inspected and approved by the Engineer prior to proceeding with construction.

B. Backfilling Shaft:

1. The excavated shaft shall be backfilled with lean concrete backfill, as shown in the Engineering Standard 6320 and the Contract Documents. If water is present, the shaft shall be dewatered prior to placement of lean concrete backfill.
2. Placement of the lean concrete backfill shall commence immediately after completing the shaft excavation and receiving the Engineer's approval of the excavation. Vibration of shaft backfill is not required.
3. The lean concrete backfill shall be deposited by a method that prevents segregation of aggregates and include adequate head.
4. If a pile socket is required, the excavated shaft shall be backfill with socket concrete backfill, as shown in the Engineering Standard 6320 and the Contract Documents.

C. Installing Pile:

1. The steel piles shall be immediately lowered into the shafts after lean concrete backfill or socket concrete is placed and secured in position. Concrete cover over the steel pile shall be 2 inches minimum.
2. The steel piles shall be placed so that the centerline of the pile at the top is within 1/2 inch of the Plan location. The steel pile shall be plumb, to within 0.3 percent of the length based on the total length of the pile.
3. Exposed portions of the steel piles and attachments shall be field-painted after installation with one coat of Carboline Carboguard 890 VOC (or approved equal), applied to a dry film thickness of 8 mils, corresponding to a wet film thickness of 10 mils. Field-paint steel piles to at least one foot below finished groundline.

D. Installing Steel Support Bracket:

1. The steel support bracket shall be field-welded to the steel pile, as applicable per the Engineering Standard 6320 and the Contract Documents.
  2. Each steel support bracket shall be field-painted, after welding to the steel pile. Field-paint with one coat of Carboline Carboguard 890 VOC (or approved equal), applied to a dry film thickness of 8 mils, corresponding to a wet film thickness of 10 mils.
- E. Installing Precast Concrete Headwall Panel:
1. The precast concrete headwall panels shall be installed from the top of the steel pile proceeding downward. The headwall panel shall make direct contact with the soil. When and where headwall panel is not in full contact with the soil being retained, either the headwall panel shall be wedged back to create contact or the void shall be filled with a free-draining material, as approved by the Engineer.
  2. When utilizing headwall panels in fill situations, the backfill layers shall be placed in accordance with Section 31 20 00.
- F. Installing End Anchors:
1. Connect culvert into the precast concrete headwall panel opening with end anchors and grout in accordance with Engineering Standard 6320 and the Contract Documents.
  2. Using pre-drilled holes in the CMP culvert as a template, drill holes into precast concrete headwall panel and clean in accordance with epoxy adhesive manufacturer instructions.
  3. Each end anchor shall be placed within 1/4" of the specified location prior to setting and bonding with epoxy adhesive, with nut tightened.
  4. Fill annular space between headwall and CMP culvert with grout.
  5. The connecting culvert shall be installed per the requirements of Section 33 42 00.
- G. Installing Precast Concrete Wingwall Panel:
1. The precast concrete wingwall panels shall be installed from the top of the steel pile proceeding downward. The wingwall panels shall make direct contact with the soil. When and where wingwall panel is not in full contact with the soil being retained, either the wingwall panel shall be wedged back to create contact or the void shall be filled with a free-draining material, as approved by the Engineer.
  2. When utilizing wingwall panels in fill situations, the backfill layers shall be placed in accordance with Section 31 20 00.

- H. Installing Handrailing:
  - 1. Install handrailing along top of headwall and wingwall in accordance with Section 34 80 53, Engineering Standard 6320 and the Contract Documents.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Steel Piling will be measured by the linear foot as specified in the Contract Documents.
- B. Shaft construction will be measured by the linear foot of shaft excavated and only that portion filled with lean concrete or socket concrete, as defined in the Contract Documents, within the specified shaft diameter.
- C. End Anchor will be measured by each unit installed in accordance with the Contract Documents.
- D. Miscellaneous Steel shall be measured as shown in the Contract Documents and as defined in Section 34 80 52.
- E. Precast Concrete Headwall and Wingwall Panels shall be measured as shown in the Contract Documents and as defined in Section 34 80 43.
- F. Corrugated Metal Pipe (CMP) Culvert shall be measured as shown in the Contract Documents and as defined in Section 33 42 00.
- G. Handrailing shall be measured as shown in the Contract Documents and as defined in Section 34 80 53.

### **4.02 PAYMENT**

- A. Steel Piling shall be paid per linear foot, which includes fabricating the pile assemblies, field splicing and field trimming the steel piles, welding attachments to the steel piles and painting the exposed portions of the steel piles and attachments.
- B. Shafts shall be paid per linear foot, which includes shaft excavation, rock socketing if needed, temporary casing if used, slurry if used, dewatering if needed, lean concrete backfill, socket concrete backfill, and installing the steel pile as detailed in the Contract Documents.
- C. End Anchor shall be paid per each unit, which shall include full compensation for furnishing labor, drilling, materials, threaded rods, nuts, epoxy adhesive, grout between headwall and culvert, tools, equipment, supplies, supervision and incidentals as detailed in the Contract Documents.
- D. Miscellaneous Steel shall be paid as defined in Section 34 80 52.



- E. Precast Concrete Headwall and Wingwall Panels shall be paid as defined in Section 34 80 43.
- F. Corrugated Metal Pipe (CMP) Culvert shall be paid as defined in Section 33 42 00.
- G. Handrailing shall be paid as defined in Section 34 80 53.

**END OF SECTION**

## SECTION 34 80 31

### BRIDGE DECK DRAINAGE SYSTEM

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Deck drainage system.
- 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.

##### 1.02 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA):
  - 1. AREMA Manual for Railway Engineering, Chapter 8, Part 29, Waterproofing.
- B. ASTM International (ASTM):
  - 1. A760, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
  - 2. A798, Standard Practice for Installing Factory-Made Corrugated Steel Pipes for Sewers and Other Applications.
  - 3. A929, Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.

##### 1.03 DEFINITIONS

- A. 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. See Division 01 for requirements for the mechanics and administration of the submittal process.
  - 2. Outlet/Downspout Fabrication and/or Layout Drawings:
    - a. Bridge drainage piping Drawings (minimum scale 1 IN equals 10 FT) with information including:
      - 1) Dimension of piping lengths.
      - 2) Invert or centerline elevations of piping crossings.
      - 3) Acknowledgement of bury depth requirements.
      - 4) Line slopes and vents.
  - 3. Product technical data including:
    - a. Acknowledgement that products submitted meet requirements of standards referenced.
    - b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
  - 4. Deck drain layout including:
    - a. Elbows.
    - b. Couplings.
    - c. Lap details.
    - d. End treatments.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Prevent damage to pipe during transit.
  - 1. Repair abrasions, scars, and blemishes.
  - 2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

**PART 2 - PRODUCTS****2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - 1. Deck Drains:
    - a. Contech Construction Products Inc.
- B. Submit request for substitution in accordance with Division 01.

**2.02 MATERIALS**

- A. Deck Drain:
  - 1. Corrugated steel pipe for deck drains shall be galvanized steel pipes with 1-1/2" x 1/4" corrugation manufactured from galvanized steel coils conforming to applicable requirements of ASTM A929 and manufactured in accordance with the applicable requirements of ASTM A760.
- B. Drainage Piping:
  - 1. Drainage piping shall be as shown on the Drawings.

**2.03 INSPECTION AND TESTING**

- A. Materials shall be sampled and tested by the current methods recommended by ASTM.
- B. The acceptance of any material by the inspector shall not be a bar to their subsequent rejection if found defective.
  - 1. Rejected material must be promptly removed from the job and replaced with acceptable material.
- C. No material shall be used until it has been accepted by the Engineer.

**PART 3 - EXECUTION****3.01 INSTALLATION**

- A. Deck Drain:
  - 1. Install corrugated steel pipe deck drain system as shown in the Drawings and in accordance with ASTM A798.

- B. Buried Piping Installation:
1. Install expansion devices as necessary to allow expansion and contraction movement.
  2. Laying Pipe In Trench:
    - a. Excavate and backfill trench in accordance with Section 31 20 00.
    - b. Clean each pipe length thoroughly and inspect for compliance to Specifications.
    - c. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
    - d. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
    - e. Except for first two (2) joints, before making final connections of joints, install two (2) full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
    - f. Lay pipe in only suitable weather with good trench conditions.
      - 1) Never lay pipe in water except where approved by Engineer.
    - g. Seal open end of line with watertight plug if pipe laying stopped.
    - h. Remove water in trench before removal of plug.
  3. Lining Up Push-On Joint Piping:
    - a. Lay piping on route lines shown on Drawings.
    - b. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
    - c. Observe maximum deflection values stated in manufacturer's written literature.
    - d. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
    - e. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.
  4. Anchorage and Blocking:
    - a. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.

- b. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
    - 1) Concrete blocks shall not cover pipe joints.
  - c. Provide bearing area of concrete in accordance with drawing detail.
5. Install insulating components where dissimilar metals are joined together.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Bridge Deck Drainage 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. Bridge Deck Drainage system will be paid at the contract lump sum price.
  - 1. The contract unit price paid for drainage system shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the drainage system, complete in place, as shown on the Drawings, as specified in this Specification Section, and as directed by the Engineer.
  - 2. Half-round perforated corrugated steel drain pipe, steel pipe, bottom pans, non-perforated round corrugated steel drain pipes, all connections and closures, joints, elbows, cleanouts and outlet hardware, concrete drainage swale or gutter, utility excavation and backfill and other associated material and incidentals and installation thereof will be considered part of the drainage system and full compensation therefore will be considered as included in the contract unit price paid for drainage system.

**END OF SECTION 34 80 31**

## SECTION 34 80 32

### ADHERED ELASTOMERIC WATERPROOFING FOR RAILROAD BRIDGES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Waterproofing membrane.
  - 2. Membrane protection.
  - 3. Flashing.
- 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 34 11 26 - Ballast.
  - 4. Section 34 80 33 - Hot Mix Asphalt (HMA) for Bridges.
  - 5. Section 34 80 52 - Metal Fabrications.

##### 1.02 REFERENCES

- A. Referenced Standards:
- B. American Railway Engineering and Maintenance-of-Way Association (AREMA):
  - 1. AREMA Manual for Railway Engineering, Chapter 8, Part 29, Waterproofing.
- C. ASTM International (ASTM):
  - 1. A924, Standard Specifications for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
  - 2. D2824, Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Nonfibered, Asbestos Fibered, and Fibered without Asbestos.
  - 3. D6134, Standard Specification for Vulcanized Rubber Sheets Used in Waterproofing Systems.

### 1.03 DEFINITIONS

A. 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. See Division 01 for requirements for the mechanics and administration of the submittal process.
2. Certification of applicator qualifications.
3. Product technical data including:
  - a. Acknowledgement that products submitted meet requirements of standards referenced.
4. Waterproofing layout:
  - a. Waterproofing membrane sheet layout and details including:
    - 1) Splice locations.
    - 2) Edge details.
    - 3) Joint details.
  - b. Membrane protection:
    - 1) Asphaltic panel or asphalt plank layout.
      - a) Edge details.
      - b) Joint details.
5. Manufacturer's authorized representative written acceptance of substrate.
6. Ponded water test report with results and all remedial measures taken as a result of a failing test.

### 1.05 QUALITY ASSURANCE

A. Qualifications:

1. Installer licensed or approved in writing by system manufacturer.



2. Installer shall have a minimum of five (5) years experience in the installation of products specified.
3. Installer shall have completed a minimum of three (3) projects in the last three (3) years on similar bridges.

### **1.06 WARRANTY**

- A. Warranty, signed by material manufacturer, stating membrane material will be free of manufacturing defects for a minimum period of 20 years.
- B. Watertightness warranty signed by installer stating completed installation will remain water tight for a minimum period of 10 years.

## **PART 2 - PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  1. Waterproofing membrane:
    - a. Carlisle Coating and Waterproofing, Inc.
  2. Membrane protection:
    - a. Asphalt planks:
      - 1) Elsro, Inc.
    - b. Asphaltic panels:
      - 1) W.R. Meadows, Inc.
  3. Bonding adhesive:
    - a. Carlisle Coating and Waterproofing, Inc.
- B. Submit request for substitution in accordance with Division 01.

### **2.02 MATERIALS**

- A. Waterproofing Membrane: Meet requirements of ASTM D6134, Type 1, EPDM or Type 2, Butyl.
- B. Membrane Protection:
  1. Meet requirements of AREMA Manual for Railway Engineering, Chapter 8, Part 29.

- a. Provide either asphaltic panels or asphalt planks, Type 1b.
2. Total thickness: 1 inch consisting of two (2) ½" layers.
- C. Adhesive for Securing Membrane and Membrane Protection: In accordance with the recommendations of the membrane manufacturer.
- D. Cement:
  1. Self-vulcanizing butyl rubber compound conforming.
  2. Viscosity at 77° F Brookfield Viscometer (#3 Spindle at 10 rpm) 1,700-3,400 cps.
  3. Total solids (minimum): 30 percent.
- E. Butyl Gum Tape for Splicing Either Membrane:
  1. Black, vulcanizable butyl rubber with an 8 mil polyethylene film backing.
  2. Tape thickness: 30 (+4) mils, including the backing.
- F. Anti-bonding Paper:
  1. Tough paper with a weight not less than 5 lbs per 100 sf.
  2. In accordance with the recommendations of the membrane and membrane protection manufacturers.
- G. Galvanized Sheet Metal: Meet the requirements of ASTM A924.
- H. Steel Flashing, Flashing Anchors and Armor Plate: In accordance with Section 34 80 52.
- I. Ballast: In accordance with Section 34 11 26.

### **2.03 INSPECTION AND TESTING**

- A. Sample and test materials by the current methods recommended by ASTM.
- B. Acceptance of any material by the inspector shall not be a bar to its subsequent rejection if found defective.
  1. Promptly remove rejected material from the job and replaced with acceptable material.
- C. Do not use any material until it has been accepted by the Engineer.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Waterproofing Membrane:
1. Apply adhesive to ballast retainers and entire surface to be waterproofed.
    - a. Apply in a thin layer (by using a roller or brush as recommended by the manufacturer) at a minimum rate of one (1) gal per 60 sf based on both mating surfaces.
  2. Membrane sheets:
    - a. Position and draw tight without stretching.
    - b. Uniformly roll up half of the membrane in a direction away from the starting edge or subsequent splice.
    - c. Apply adhesive to the exposed area.
    - d. Allow adhesive to dry so as to not stick to a dry finger touch and all solvent is evaporated.
    - e. Unroll the membrane and press firmly and uniformly in place, using care to avoid trapping of air.
    - f. Repeat the same procedure for the remaining half of the membrane sheets.
    - g. Avoid wrinkles and buckles.
    - h. Position each succeeding sheet to fit the previously installed sheet and splice.
  3. Splices:
    - a. Lap type as shown on the Drawings.
    - b. Clean all seam, lap and splice areas with heptane, hexane, toluene, trichloroethylene or white gasoline, using a clean cloth, mop or similar synthetic cleaning device.
    - c. Spread cement continuously on seam, lap and splice areas at a uniform rate of not less than 2 gal per 150 sf based on both mating surfaces.
    - d. After cement is allowed to dry until it will not stick to a dry finger touch, apply butyl gum tape to cemented area of membrane, press firmly into place, obtain full contact.

- e. Avoid bridging and wrinkles.
  - f. Reinforce corner splices with two (2) continuous layers of rubber membrane over one (1) layer of butyl tape.
4. Flash all projecting elements passing through membrane waterproofing with prefabricated or field-fabricated boots or fitted coverings, as necessary to provide watertight construction.
- a. Use Butyl gum tape between layers of rubber membrane.
5. Construct waterproofing at expansion joints of bridge decks, as shown on the Drawings.
6. Patch any holes in the membrane sheeting with a minimum overlap of 4 inches and in accordance with manufacturer's instructions.
7. Exercise care to prevent damage to the waterproofing membrane by men or equipment during construction.
- B. Membrane Protection:
- 1. Asphaltic panels:
    - a. Apply in two (2) layers with the joints staggered.
      - 1) Lay panels tightly jointed.
      - 2) Adhesive: Same as specified for the Butyl rubber or EPDM membrane.
      - 3) Fill any voids between the panels with a material compatible to both the membrane and the panel.
    - b. Where edges or protrusions of asphaltic panels are exposed to prolonged sunlight exposure, coat exposed areas with Fiber Aluminum Roof Coating meeting ASTM D2824, Type II at a rate of 12 sf per gallon, for a 1/8 inches thickness.
  - 2. Asphalt planks:
    - a. Lay in a coating of bonding adhesive.
    - b. Adhesive: Same as specified for the Butyl rubber or EPDM membrane.
    - c. Adhesive: Apply at a rate of not less than 1 gal per 100 sf.
    - d. Fill any voids between the panels with a material compatible to both the membrane and the panel.
- C. Steel Flashing:

1. Attach with bolts per the Drawings.
  2. Refer to Specification Section 34 80 52 for expansion bolt requirements.
- D. Waterproofing Protection:
1. As soon as the membrane protection has been completed, cover the waterproofing with HMA on concrete bridge decks or with a 6 inches layer of ballast on steel bridge decks to protect the waterproofing from sunlight.
  2. Do not place any equipment on the waterproofing prior to placement of the Waterproofing Protection.

### **3.02 FIELD QUALITY CONTROL**

- A. Employ and pay for services of material manufacturer's field service representative(s) to:
1. Supervise installation.
  2. Sign and provide SCRRA with a written warranty.
- B. Ponded water testing: On bridges with entire deck waterproofed with membrane waterproofing:
1. Pond 2 inches of water for 24 hours on all horizontal surfaces:
    - a. Plug all openings as required.
    - b. Protect adjacent areas from water damage.
    - c. Remove all water after test.
    - d. Repair all leaks and other discrepancies as identified by manufacturer's authorized representative.
    - e. Retest repaired areas until satisfactory test results are obtained.
    - f. Furnish written report.

## **PART 4 - MEASURE AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Adhered Elastomeric Waterproofing for Railroad Bridges 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. Adhered Elastomeric Waterproofing for Railroad Bridges 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. Adhesive, asphalt planks or sheets, steel sheeting, steel flashing, bolts and connectors for flashing, armor plates, adhesive anchors, butyl rubber or EPDM waterproofing membrane and other associated materials and incidentals and installation thereof shall be considered part of the waterproofing and full compensation therefore shall be considered as included in the contract unit price paid for waterproofing.

**END OF SECTION 34 80 32**

## SECTION 34 80 33

### HOT MIX ASPHALT (HMA) FOR TRACK AND BRIDGES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Hot mix asphalt (HMA) for track underlayment, bridge decks, and bridge approaches.
- 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 32 12 00 Hot Mix Asphalt (HMA) Pavement
  - 4. Section 34 11 27 - Sub-Ballast and Aggregate Base.

##### 1.02 REFERENCES

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

##### 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.
  - 3. Asphalt design mix.

## 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.
  - 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.
  - 4. Asphaltic emulsion for the tack coat shall be of the grade designated by the Engineer.
    - a. The asphaltic emulsion shall be in conformance with the Caltrans Standard Specifications, Section 94.
  - 5. Paving asphalt to be used as a binder for pavement reinforcing fabric shall be a steam-refined paving asphalt in conformance with the Caltrans Standard Specifications, Section 92.
    - a. The paving 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.
- C. HMA for track underlayment: Type A with  $\frac{3}{4}$ " maximum, coarse aggregate gradation.
- D. Prime Coat:
  - 1. Prime coat shall be an emulsified asphalt Grade RS-2, conforming to Caltrans Standard Specifications, Section 94.
- E. Tack Coat:
  - 1. Tack coat shall be a liquid asphalt Type SS-1, conforming to Caltrans Standard Specifications, Section 94.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. When placing HMA for track underlay, prepare subgrade in accordance with Section 31 20 00.
- B. Schedule placement of asphalt paving material when the precipitation probability, within 3 hours prior to the start of such operations, is less than 50 percent.
- 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 prime coat.

1. Repair holes and depressions in existing surfaces by removal to sound material and replace with an asphalt-aggregate patching material.
2. Compact patch to produce a tight surface conforming to the adjacent paving area.
3. Stabilize rocking Portland cement concrete slabs by undersealing or cracking and seating.
4. Fill wide joints and cracks with asphaltic concrete/sand mix material and compact.

### **3.02 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. HMA for bridge and bridge approaches shall conform to the following thickness requirements:
  1. The track underlay for the bridge approaches shall be permitted to be placed in one 8 inches lift.
  2. The traffic surface shall be permitted to be placed in one 4 inches thick lift.
- C. 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.
- D. 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.
- E. Following application of the tack coat, the HMA shall be spread in conformance with the Caltrans Standard Specifications, 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.

### **3.03 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.
  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 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 making 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**

### **4.01 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.

**END OF SECTION 34 80 33**

## SECTION 34 80 43

### PRECAST AND PRESTRESSED CONCRETE FOR RAILROAD BRIDGES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Precast and prestressed concrete.
- B. Related Specifications 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 34 80 61 - Painting and Protective Coatings for Railroad Bridges.

##### 1.02 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA).
  - 1. Chapter 8 - Concrete Structures and Foundations.
- B. ASTM International (ASTM):
  - 1. A36, Standard Specification for Carbon Structural Steel.
  - 2. A108, Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.
  - 3. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
  - 4. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
  - 5. C33, Standard Specification for Concrete Aggregates.
  - 6. C150, Standard Specification for Portland Cement.
  - 7. C260, Standard Specification for Air-Entraining Admixtures for Concrete.

8. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
  9. C949, Standard Specification for Chemical Admixtures for Concrete.
  10. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
  11. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
  12. D573, Standard Test Method for Rubber—Deterioration in an Air Oven.
  13. D1149, Standard Test Methods for Rubber Deterioration-Cracking in an Ozone Controlled Environment.
  14. D2240, Standard Test Method for Rubber Property - Durometer Hardness.
  15. D4711, Standard Test Method for Sulfonic and Sulfuric Acids in Alkylbenzene Sulfonic Acids.
  16. E329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- C. American Welding Society (AWS):
1. A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
  2. A5.5, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
  3. D1.1, Structural Welding Code - Steel.
  4. D1.4, Structural Welding Code - Reinforcing Steel.
- D. Precast/Prestressed Concrete Institute (PCI):
1. PCI MNL-116-Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.
  2. PCI Design Handbook - Precast and Prestressed Concrete.

### 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. Sizes, types and manufacturer of neoprene bearing pads.
  - d. Hardware to be utilized to support suspended appurtenances.
3. Shop Drawings and erection plans for precast units, their connections and supports showing:
- a. Member size and location.
  - b. Size, configuration, location and quantity of reinforcing bars and prestressing strands.
  - c. Initial prestress forces.
  - d. Size and location of openings verified by Contractor.
  - e. Size, number, and locations of embedded metal items and connections.
  - f. Required concrete strengths.
  - g. Identification of each unit using same standard marking numbers as used to mark actual units.
4. Concrete mix design(s) including submittal information defined in Section 03 31 00.
5. Copies of source quality control tests.
6. Certification of manufacturer's testing facility qualifications.

#### **1.04 QUALITY ASSURANCE**

A. Qualifications:

1. Provide precast and prestressed concrete units produced by a certified manufacturer by the Prestressed Concrete Institute Plant Certification Program.
  - a. Manufacturer shall be certified in Product Group and Category B1 for non-prestressed precast concrete.
  - b. Manufacturer shall be certified in Product Group and Category B4 for prestressed precast concrete.
2. Provide units manufactured by plant which has regularly and continuously engaged in manufacture of units of same type as those required for a

minimum of three (3) years.

3. Assure manufacturer's testing facilities meet requirements of ASTM E329.
4. Welding operators and processes to be qualified in accordance with:
  - a. AWS D1.1 for welding steel shapes and plates.
  - b. AWS D1.4 for welding reinforcing bars.
5. Welding operators to have passed qualification tests for type of welding required during the previous 12 months prior to commencement of welding.

## **PART 2 - PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  1. Headed studs and deformed bar anchors:
    - a. Nelson Stud Welding Div., TRW, Inc.
    - b. KSM Division, Omark Industries.
  2. Bearing pads:
    - a. Voss Engineering, Inc. 'Fiberlast'
- B. Submit request for substitution in accordance with Division 01.

### **2.02 MATERIALS**

- A. Embedded Steel Plates and Shapes: ASTM A36.
- B. Elastomeric Bearing Pads:
  1. AREMA Chapter 15, Article 10.6.2.
- C. Random Oriented Fiber Elastomeric Pads: Made of high-quality ozone resistant virgin elastomer combined with synthetic fibers. Pads shall conform to the following minimum material properties:
  1. Hardness (Shore A, ASTM D2240): 80 ±5.
  2. Compression:
    - a. Minimum Ultimate Strength: 8000 psi.



3. Shear Modulus (G): 230 ±30 psi Based on tests conducted according to 70° to 80° F under uniform compressive stresses of 500, 1000 and 1500 psi and at an applied horizontal shear plus slip strain of 50 percent. This value is applicable to both concrete-to-concrete and steel-to-concrete surfaces. G is constant in all directions parallel to the bearing plane.
  4. Tensile Strength (ASTM D412, Die C): 1000 ±100 psi
  5. Elongation:
    - a. Ultimate Elongation, %: 40 percent minimum.
    - b. Ozone Resistance (per ASTM D1149) Exposed 50 hours @ 100 pphm @ 100° F Elongation: 40 percent minimum.
    - c. Heat Aging (per ASTM D573) 70 hrs @ 212° F in forced air oven Elongation, % Change: —25 percent max. 6.
    - d. Oil Imersion Oil Immersion per ASTM D4711 70 HRS @ 212° F in ASTM #3 oil Volume Change, %: 125 percent max.
- D. Cement:
1. Comply with ASTM C150, Type I or III.
- E. Aggregates for Normal Weight Concrete:
1. ASTM C33 with coarse aggregate meeting the gradation for size 67 as stated in ASTM C33.
  2. All fine aggregate to be natural not manufactured.
- F. Admixtures:
1. Only liquid admixtures may be used.
  2. All admixtures must be from same manufacturer.
  3. Air entraining admixtures shall conform to ASTM C260 and shall be used to produce 7 percent ±1 percent entrained air in the concrete after all admixtures have been incorporated.
  4. Water reducing admixtures shall be used only with the approval of the Engineer and shall conform to ASTM C949, Types A, B, D, or E.
  5. High-range water reducers (superplasticizers) and retarding admixtures, in quantities appropriate for the ambient temperatures, may be permitted, subject to the approval of the Engineer.
  6. The use of calcium chloride or any admixture containing chloride ions will not be permitted.

- G. Flyash:
1. Flyash, Type C, meeting the requirements of ASTM C618 may be used as a cement replacement with the approval of the Engineer.
    - a. Type F may be used to modify potentially reactive aggregates.
    - b. This mix shall be subject to the requirements of ASTM C1260.
    - c. Flyash may replace up to 15 percent, by weight, of the cement.
- H. Water:
1. Potable, clean.
  2. Free of oils, acids, and organic matter.
- I. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement and admixtures measured as a weight percent of cement to not exceed 0.06 for prestressed concrete and 0.10 for all other precast concrete.
- J. Prestressing Strands:
1. 270K high tensile strength uncoated seven (7) wire strand.
  2. Manufacture and test strands in accordance with ASTM A416.
- K. Reinforcing Steel and Welded Wire Reinforcement: See Section 03 21 00.
- L. Headed Studs:
1. ASTM A108.
  2. Minimum yield strength: 50,000 psi.
  3. Minimum tensile strength: 60,000 psi.
- M. Deformed Bar Anchors:
1. ASTM A496.
  2. Minimum tensile strength: 80,000 psi.
  3. Minimum yield strength: 70,000 psi.
- N. Electrodes:
1. E70 series conforming to AWS A5.1 or AWS A5.5 for welding steel shapes and plates.
  2. E90 series conforming to AWS A5.5 for welding rebar.

- O. Grout:
1. Grout shall consist of one part Type III Portland Cement to three parts of fine aggregate, by weight, mixed with a gaging solution made of one part Sika Set to five parts by volume.
  2. The following mix proportions will yield one cubic foot of grout:
    - a. 35 lbs cement.
    - b. 105 lbs fine aggregate.
    - c. 1.25 gal water.
    - d. 1 qt Sika Set.
  3. At temperatures above 50° F grout will take initial set in approximately 3 hours and reach design strength in approximately 24 hours.

### **2.03 MIXES**

- A. See Section 03 31 00.
- B. Do not begin fabrication of units until concrete mix design(s) have been approved by Engineer.

### **2.04 FABRICATION**

- A. Do not fabricate units until Shop Drawings and Mix Design(s) have been approved by Engineer and returned to Contractor and support locations have been field verified by Contractor.
- B. Manufacture, quality, dimensional and erection tolerances of all units to be in accordance with AREMA Chapter 8 and PCI MNL-116.
- C. Cast all members in smooth rigid forms which will provide straight, true members of uniform thickness and uniform color and finish.
- D. Use sand cement grout mixture to fill all air pockets and voids, and to repair chipped edges.
- E. Finish all repairs smooth and to match adjacent surface texture and color.
- F. Incorporate embedded plates, angles, lifting devices, and other inserts into members at time of manufacture.
  1. Provide embedded items as shown on the Plans unless prior approval is received from Engineer to do otherwise.
  2. Cast lifting devices into units as shown on Plans.

- a. Remove or fill lifting devices after units are erected.
- G. Automatically weld headed studs and deformed bar anchors to members to provide full penetration weld between studs, bar anchors and members they are attached to.
- H. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.
- I. Mark each unit as indicated on the erection plans.
  - 1. Place mark on non-exposed-to-view surface.
- J. Coat or finish ends of exposed prestressing strands to prevent rusting.
- K. Fabricate the following types of precast and prestressed units:
  - 1. Precast slab beams.
    - a. Reinforce as indicated.
  - 2. Precast, prestressed slab beams.
    - a. Reinforce as indicated.
  - 3. Precast, prestressed double-box beams.
    - a. Reinforce as indicated.
  - 4. Precast concrete members as shown on Plans:
    - a. Reinforce as indicated.

## **2.05 DELIVERY, STORAGE AND HANDLING**

- A. Units shall be stored in such a way as to permit the Inspector's access to all sides at all times, and the Fabricator's access for shipment without additional moving.
- B. Transportation of prestressed units shall not be undertaken until the full 28 day concrete strength has been achieved, or by order of the Engineer.
- C. Units shall be handled such that the points of the support and direction of the reactions with respect to the unit are approximately the same during transportation and storage as when the unit is in its final position.
  - 1. Care shall be taken during storage, hoisting, and handling of the precast units to prevent cracking or damage.
  - 2. Units damaged by improper storage or handling shall be replaced or repaired to the satisfaction of the Engineer by the Contractor at his expense.

- D. Units shall be stored above ground on skids or other supports to keep items free of dirt and other foreign debris.

## **2.06 SOURCE QUALITY CONTROL**

- A. During production of precast concrete units, conduct strength tests of concrete placed in units as required in Specification Section 03 31 00 for concrete placed during fabrication.
  - 1. 4 inches dia. x 8 inches cylinders will be allowed for testing.
  - 2. Results of strength tests to be sent to The Engineer, Contractor and SCRRA within 24 hours.
  - 3. Test reports to indicate units they represent.
- B. When approved by Engineer, strength tests may be made by precast manufacturer after he has submitted certification that his testing facilities meet the requirements of ASTM E329.
- C. The SCRRA must be allowed to inspect all Contract work at his own discretion.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Verify acceptability and location of supports to receive units.
  - 1. Check bearing surfaces to determine that they are level and uniform.
- B. Do not place design live load on structure until supports have reached their 28 day required compressive strengths.

### **3.02 ERECTION**

- A. Give consideration to possible lack of stability or capacity of partially completed structure.
- B. Contractor to be responsible for guying, shoring, and bracing individual members as necessary to resist forces due to wind, erection, or any other source that may occur before structure is completed.
- C. Use only erection equipment adequate for placing units at lines and elevations indicated on Plans.
  - 1. Do not damage units or existing construction during erection.
  - 2. Erect units using lifting devices cast into the units.
- D. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.

- E. Coat adjoining surfaces of wingwalls and end caps with grout prior to wingwall installation.
- F. After all precast units are erected and all precast unit connections have been made, coat all exposed surfaces of the connections as indicated on Plans.
  - 1. See Section 34 80 61.

### **3.03 FIELD QUALITY CONTROL**

- A. Causes for rejection of units include, but are not necessarily limited to the following:
  - 1. Cracked units.
  - 2. Chipped, broken, or spalled edges.
  - 3. Units not within allowable casting tolerances.
  - 4. Voids or air pockets which, in opinion of Engineer, are too numerous or too large.
  - 5. Non-uniform finish or appearance.
  - 6. Low concrete strength.
  - 7. Improperly placed embedded items and/or openings.
  - 8. Exposed wire mesh, reinforcing or prestressing strands.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Precast and prestressed 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.

### **4.02 PAYMENT**

- A. Precast and prestressed 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.

- B. Connection rods and associated hardware and other materials, bearing pads and embedded steel items shall be considered part of the member and full compensation therefore shall be considered as included in the contract unit price paid for furnishing and erecting the precast and prestressed unit in-place.

**END OF SECTION 34 80 43**

## SECTION 34 80 51

### STRUCTURAL STEEL FOR RAILROAD BRIDGES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Structural steel, including the fabrication and erection of framing and bracing members, including connections.
- 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 31 00 - Structural Concrete.

##### 1.02 REFERENCES

- A. American Institute of Steel Construction (AISC):
  - 1. 303, Code of Standard Practice for Steel Buildings and Bridges dated March, 2005.
  - 2. Quality Certification Program for Fabricators.
- B. American Railway Engineering and Maintenance-of-Way Association (AREMA).
  - 1. Manual for Railway Engineering, Chapter 15.
- C. ASTM International (ASTM):
  - 1. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
  - 2. A36, Standard Specification for Carbon Structural Steel.
  - 3. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 4. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.



5. A307, Standard Specifications for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
6. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
7. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
8. A563, Standard Specification for Carbon and Alloy Steel Nuts.
9. A588, Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4 inches Thick<sup>1</sup>.
10. A709, Standard Specification for Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges.
11. F436, Standard Specification for Hardened Steel Washers.
12. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

D. American Welding Society (AWS):

1. A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
2. A5.5, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
3. A5.17, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
4. A5.18, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
5. A5.23, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
6. A5.28, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
7. D1.5, Bridge Welding Code - Steel (referred herein as AWS Code).
8. Steel stud connectors and their installation to comply with requirements of AWS Code.

### 1.03 SUBMITTALS

A. Shop Drawings:

1. See Division 01 for requirements for the mechanics and administration of the submittal process.
2. Fabrication and/or layout Plans:
  - a. Prepare Shop Drawings under National Institute of Steel Detailing Quality Procedures Program certification.
  - b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
    - 1) All Shop Drawings must be checked and signed "approved" before submittal.
    - 2) Show all cuts, copes, and holes.
    - 3) Indicate all shop and field bolts.
    - 4) Indicate all shop and field welds using AWS symbols.
    - 5) Be reviewed and sealed by a Professional Engineer retained by Contractor to verify conformance with design criteria stipulated in the Contract Documents.
  - c. Prepare complete erection Plans showing the location and marks of all pieces.
    - 1) Copies of up-to-date erection Plans shall accompany the Shop Drawings.
      - a) Use match marks on the erection Plans to indicate the sheet number on which each particular member is detailed.
3. Product technical data including:
  - a. Acknowledgement that products submitted meet requirements of standards referenced.
  - b. Manufacturer's installation instructions.
  - c. Detailed supplemental specification relating to load indicator washers or high-strength bolts - alternate design for approval of Engineer (submitted at Contractor's option if desired by Contractor for use).
  - d. Source and certification of quality for high-strength bolts, nuts and washers.

4. Certifications:
  - a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
  - b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
  - c. Welder qualification data and prequalified procedures.
5. Test reports:
  - a. Certified copies of mill tests.
  - b. Manufacturer's load test and temperature sensitivity data for expansion anchor bolts and adhesive anchor bolts.
  - c. Testing agency inspection and test reports for structural steel work in the shop and in the field.

#### **1.04 QUALITY ASSURANCE**

- A. Qualifications:
  1. Steel fabricator:
    - a. Minimum of 10 years experience in fabrication of structural steel and shall be certified under AISC Quality Certification Program Category III.
    - b. Use a Professional Engineer on fabrication staff.
  2. Steel erector:
    - a. Minimum of 10 years of experience in erection of structural steel.
  3. Qualify welding procedures and welding operators in accordance with AWS.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store steel members above ground on skids or other supports.
  1. Keep free of dirt and other foreign material and protect against corrosion.

#### **1.06 DEFINITION**

- A. Code: AISC 303, Code of Standard Practice for Steel Buildings and Bridges.

- B. SCRRRA: May mean the SCRRRA's Designated Representative for Construction as defined by the Building Code.
- C. Galvanizing: Hot-dipped galvanizing per ASTM A153 with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

## **PART 2 - PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - 1. High-strength bolts:
    - a. Bethlehem Steel Corporation.
    - b. Lewis Bolt & Nut Company.
    - c. Nucor Fasteners.
    - d. St. Louis Screw and Bolt Company.
  - 2. Headed studs and deformed bar anchors:
    - a. Nelson Stud Welding Division, TRW, Inc.
    - b. Stud Welding Products, Inc.
  - 3. Expansion anchor bolts:
    - a. Kwik Bolts by Hilti, Inc.
    - b. Trubolt by ITW Ramset/Red Head.
    - c. Powerbolt by Powers Rawl.
  - 4. Adhesive anchors bolts:
    - a. HVA Adhesive Anchor System by Hilti.
    - b. HIT HY 150 Adhesive Anchor by Hilti.
    - c. HSE 2411 Epoxy Adhesive Anchor by Hilti.
    - d. EPCON Ceramic 6 Epoxy by ITW Ramset/Red Head.
    - e. Power Fast by Powers Rawl.
    - f. Needle Capsule Anchor Systems by Powers Rawl.

- B. Submit request for substitution in accordance with Division 01.

## 2.02 MATERIALS

- A. Steel, Structural Shapes and Plate (unless noted otherwise on Plans):
  - 1. All main load-carrying members: ASTM A709, Grade to be noted on Plans.
- B. Plate and Bar: ASTM A36.
- C. Pipe: ASTM A53, Grade B (Type E or S) (Fy=35).
- D. Hollow Structural Sections (HSS):
  - 1. Round: ASTM A500 Grade B or C.
  - 2. Square or rectangular: ASTM A500 Grade B or C.
- E. High-Strength Bolts, Nuts and Washers, ASTM A325 with ASTM A563 nuts:
  - 1. High-strength bolts:
    - a. Provide two (2) ASTM F436 washers for all bolts.
    - b. Provide beveled washers at connections of sloped/tapered sections.
    - c. Type to match.
- F. Welding Electrodes (AWS):
  - 1. Shielded metal arc: AWS A5.1 or AWS A5.5, E70XX or E801X-X.
  - 2. Submerged arc: AWS A5.17 or AWS A5.23, F7XX-EXXX or F8XX-EXXX-XX.
  - 3. Gas metal arc: AWS A5.18, E70S-X or E70U-1 or AWS A5.28, ER805-XX, E80C-XXX.
- G. Anchor Rods and Bolts:
  - 1. ASTM F1554, Grade 55 with weldability supplement S1 for threaded rods.
- H. Deformed Anchor Rods:
  - 1. Deformed anchor rods:
    - a. ASTM F1554, Grade 36.
    - b. Minimum yield strength: 36,000 psi.
    - c. Minimum tensile strength: 58,000 psi.

- d. Straight, unless indicated otherwise.
- I. Nonshrink Grout: See Section 34 80 41.

## 2.03 FABRICATION

- A. Comply with requirements of AREMA Chapter 15 and AISC Specification with modifications and additional requirements specified herein.
  - 1. Identify high-strength steel material in fabricated members in accordance with ASTM A6.
- B. Minimize the amount of field welding.
  - 1. Shop assemble components into largest size possible commensurate with transportation and handling limitations.
  - 2. Shop connections: Bolted with high-strength bolts or welded.
- C. One-sided or other types of eccentric connections not indicated will not be permitted without prior approval.
- D. Field Connections: Provide bolts for all field connections except where shown otherwise on the Plans.
  - 1. Use high-strength bolts unless shown or specified otherwise.
  - 2. If structural steel details shown on design Plans are not compatible with selected erection procedures, submit proposed modifications for review.
  - 3. Connections to structural steel provided by others: Provide all connectors and coordinate location of bolt holes to match connection holes in steel provided by others.
- E. Cut, drill, or punch holes in accordance with AREMA Section 15.3.2.6 and AREMA Section 15.3.2.7.
- F. Make splices only where indicated or where approved.
- G. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.
- H. Flame cut bevels for welds, provided such cutting is done automatically.
  - 1. Leave free of burrs and slag by grinding or planing the cut edges.
- I. Grind smooth all rough welds and sharp steel edges shall be ground to approximately 1/8" radius.
- J. Tolerances (unless noted otherwise on Plans):

1. ASTM A6: When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating, and mechanical straightening, subject to the limitations of the AISC Specification.
2. Fabrication tolerance:
  - a. Member length:
    - 1) Framed members 30 feet or less: 1/16".
      - a) Over 30 feet: 1/8".
  - b. Member straightness:
    - 1) 10 percent of the unbraced length multiplied by 1/16" or 1/4", whichever is greater.
  - c. Specified member camber (except compression members):
    - 1) 10 percent of the unbraced length multiplied by 1/16" or 1/4", whichever is greater.
    - 2) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
    - 3) Camber shall be measured in fabrication shop in unstressed condition.
  - d. At bolted splices, depth deviation shall be taken up by filler plates.
    - 1) At welded joints, adjust weld profile to conform to variation in depth.
    - 2) Slope weld surface per AWS requirements.
  - e. Finished members shall be free from twists, bends and open joints.
    - 1) Sharp kinks, bends and deviation from the above tolerances are cause for rejection of material.

## 2.04 WELDING

- A. Comply with AREMA Chapter 15, AWS Code, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
  1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.

- B. Test and qualify welders, welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
  - 1. Conduct tests in presence of approved testing agency.
  - 2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.
- C. Welding of Fracture Critical Members shall be in accordance with the requirements of AREMA Section 15.1.14.
- D. Before Starting Welding:
  - 1. Carefully plumb and align members in compliance with specified requirements.
  - 2. Fully tighten bolts.
  - 3. Comply with Section 3 of AWS Code for assembly and surface preparation.
  - 4. Preheat base metal to temperature stated in AWS Code.
    - a. When no preheat temperature is given in AWS Code and base metal is below 50° F, preheat base metal to at least 70° F.
    - b. Maintain temperature during welding.
    - c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 inches, whichever is greater, to specified preheat temperature.
    - d. Maintain this temperature during welding.
  - 5. Each welder shall use identifying mark at welds.
- E. Make flange welds before making web welds.
- F. Where groove welds have back-up plates, make first three (3) passes with 1/8" round electrodes.
  - 1. Use backup plates in accordance with AWS Code, extending minimum of 1 inch either side of joint.
- G. Flame cut edges of stiffener plates at shop or field butt weld.
  - 1. Do not shear.
- H. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.
- I. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS Code.



- J. Do not perform welding when ambient temperature is lower than 0° F or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.
- K. Deformed Anchors Rods:
  - 1. Automatically end welded in accordance with the AWS Code and manufacturer's recommendations.
  - 2. Fillet welding of deformed bar anchors is not allowed unless approved by Engineer.

## **2.05 SHOP COATING**

- A. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.
- B. Do not coat following surfaces:
  - 1. Machined surfaces, surfaces adjacent to field welds, and surfaces fully embedded in concrete.
  - 2. All other members for which no coating is specified.
- C. Clean thoroughly all surfaces not coated before shipping.
  - 1. Remove loose mill scale, rust, dirt, oil and grease.
  - 2. Protect machined surfaces.

## **2.06 SOURCE QUALITY CONTROL**

- A. Contractor must pay for all inspection and testing:
  - 1. Testing:
    - a. Employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
    - b. Independent testing agency shall have a minimum of five (5) years performing similar work and shall be subject to SCRRRA's approval.
- B. Responsibilities of Testing Agency:
  - 1. Inspect shop and field welding in accordance with AREMA Section 15.3.5.5 including the following non-destructive testing:
    - a. All full-penetration welds in girder webs and flanges shall be inspected by the radiographic method.

- b. All flange to web welds shall be inspected by the ultrasound method.
  - c. All fillet welds on bearing stiffeners shall be inspected by the ultrasound method.
  - d. At least 25 percent of all other welds shall be inspected by the ultrasonic or magnetic particle method.
    - 1) If any defects are found, 100 percent inspection by the ultrasonic or magnetic particle shall be required.
  - e. Inspection of welded work for Fracture Critical Members shall be in accordance with AREMA Chapter 15.
  - f. Time delay prior to NDT of weld repairs to groove welds of ASTM A588 or ASTM A709 material over 2 inches in thickness subject to tensile stress, shall be 16 hours minimum.
- 2. Inspect high-strength bolting in accordance with AREMA Section 15.3.5.4.
  - 3. Inspect structural steel which has been erected.
  - 4. Prepare and submit inspection and test reports to Engineer.
    - a. Assist Engineer to determine corrective measures necessary for defective work.
- C. All spans shall be shop-assembled and piece marked. During assembly and reaming, all bolts shall be placed in holes as work progresses to assure proper fit. Spans may be disassembled prior to shipping.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Contractor is solely responsible for safety.
  - 1. Construction means and methods and sequencing of work is the prerogative of the Contractor.
  - 2. Partially complete structural members shall not be loaded without an investigation by the Contractor.
  - 3. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

- B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment is the responsibility of the Contractor.
1. Use temporary bracing to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
  2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
  3. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
    - a. If not obvious from experience or from the Plans, the Contractor shall confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
  4. Remove and dispose of all temporary work and facilities off-site.
- C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
1. Report defects in work-in-place which may influence satisfactory completion of the work.
  2. Absence of such notification will be construed as acceptance of work-in-place.
- D. Field Measurement:
1. Take field measurements as necessary to verify or supplement dimensions indicated on the Plans.
  2. Contractor responsible for the accurate fit of the work.
- E. Check the elevations of all finished pier caps and the location and alignment of all anchor bolts and bolt holes before starting erection.
1. Notify Engineer of any errors or deviations found by such checking.

### 3.02 ERECTION

- A. Use light drifting necessary to draw holes together.

1. Drifting to match unfair holes is not allowed.
- B. Welding:
1. Conform to AWS D1.5 and requirements of this Specification.
  2. When joining two (2) sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.5 procedure.
- C. Shore existing members when unbolting of common connections is required.
1. Use new bolts for rebolting connections.
- D. Clean stored material of all foreign matter accumulated during erection period.
- E. Clean bearing and contact surfaces before assembly.
- F. Anchor Bolts:
1. Cast-in-place anchor bolts:
    - a. Anchor bolt location tolerance: 1/8".
    - b. Tie anchor bolts in position to embedded reinforcing steel using wire.
    - c. Welding or tack welding is prohibited.
    - d. Provide steel templates for location anchor bolts.
  2. Anchor bolts installed in precast holes:
    - a. If anchor bolts are to be grouted into the holes prior to the placement of the span, location tolerance of the anchor bolts shall be 1/8".
      - 1) If anchor bolts are to be installed after the span is placed, the hole location tolerance shall be 1/2".
    - b. Grout anchor bolts into place with non-shrink grout.
    - c. Used supplied bearing pads or sole plates as template.
    - d. Refer to Section 34 80 41 for non-shrink grout requirements.
  3. Anchor bolts installed in drilled holes:
    - a. If anchor bolts are to be grouted into the holes prior to the placement of the span, location tolerance of the anchor bolts shall be 1/8".
      - 1) If anchor bolts are to be installed after the span is placed, the hole location tolerance shall be 1/2".

- b. Grout anchor bolts into place with non-shrink grout.
  - c. Used supplied bearing pads or sole plates as template.
  - d. Refer to Section 34 80 41 for non-shrink grout requirements.
- G. Install high strength bolts with hardened washers.
- 1. Install and tighten in accordance with AREMA Chapter 15.
  - 2. Coordinate installation with inspection.
    - a. Do not start installation until coordination with Testing Agency is complete.
  - 3. Slip-critical connections: Perform calibration testing for all methods of installation of high-strength bolts in accordance with AREMA Chapter 15.
    - a. Turn-of-nut tightening: Torque wrenches shall be used only by laboratory personnel.
    - b. Calibrated wrench tightening: Calibrate on a daily basis.
    - c. Direct tension indicator tightening: If previously approved by Engineer.
  - 4. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.
- H. Do not use gas cutting to correct fabrication errors.
- 1. Make no such corrections without prior approval of the Engineer.
  - 2. Burning of holes: Not permitted.
- I. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.
- J. Tighten and leave in place erection bolts used in welded construction.
- K. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.
- L. After bolts are tightened, upset threads of A307 unfinished bolts and anchor bolts to prevent nuts from backing off.
- M. After erection, grind smooth all sharp surface irregularities resulting from field cutting or welding; power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.

### **3.03 CLEANING AND REPAIR OF SHOP PRIMER PAINT**

- A. After erection, clean all steel of mud or other foreign materials, and repair any damage.
  - 1. Touchup coatings to comply with Section 34 80 61.

## **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. Structural steel for use in bridge structures will be measured by the unit computed by the Engineer from the nominal weight and dimensions shown on the Plans.
  - 1. The weight of rolled shapes and structural plates will be computed on the basis of their nominal weight and dimensions, without deductions for copes, cuts, and holes.
  - 2. The computed weight of the completed members will not include allowances for bolt holes or account for the weight of bolts, washers, nuts, and welds, whether installed in the shop or in the field.

### **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.
- B. Structural steel for use in bridge structures will be paid for furnishing structural steel and erecting structural steel complete in-place.
  - 1. The contract price paid for structural steel shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for all work involved in constructing, furnishing, transporting, handling, and erecting units in-place as shown on the Plans, as specified in these Specifications and as directed by the Engineer.

2. The contract price paid structural steel shall include, but shall not be limited to, furnishing all bolts, nuts and washers, stud connectors, welding materials, bearing plates and pads, or other materials required for the erection and connection or splicing of the structural steel, finishing the structural steel as required by these Specifications and the Plans, and conforming to the qualification and testing requirements associated with member fabrication.
3. The contract price paid for structural steel shall include, but shall not be limited to, connecting and splicing the structural steel, installing stud connectors, installing bearing plates and pads, furnishing and applying caulk, sealants and fillers, furnishing and placing mortar or grout for masonry or bearing plates and anchor bolts, checking bolt tension, and conforming to qualification and testing requirements associated with member erection, connection or splicing.
4. The contract price paid for structural steel shall include, but shall not be limited to, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in cleaning and applying paint and protective coatings (non-metallic) and metallic coatings to structural steel as shown on the Plans, and as specified in these Specifications and as specified by the Engineer.

**END OF SECTION 34 80 51**

## SECTION 34 80 52

### METAL FABRICATIONS FOR RAILROAD BRIDGES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
  - 2. Design of all temporary bracing not indicated on 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 34 80 51 - Structural Steel For Railroad Bridges.
  - 4. Section 34 80 61 - Painting and Protective Coatings for Railroad Bridges.

##### 1.02 REFERENCES

- A. American Institute of Steel Construction (AISC):
  - 1. Manual of Steel Construction - Allowable Stress Design (ASD).
- B. ASTM International (ASTM):
  - 1. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
  - 2. A36, Standard Specification for Carbon Structural Steel.
  - 3. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 4. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 5. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.



6. A276, Standard Specification for Stainless Steel Bars and Shapes.
  7. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  8. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
  9. A563, Standard Specification for Carbon and Alloy Steel Nuts.
  10. A588, Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4 inches Thick1.
  11. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
  12. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
  13. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
  14. A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
  15. A992, Standard Specification for Steel for Structural Shapes.
  16. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
  17. F594, Standard Specification for Stainless Steel Nuts.
  18. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- C. American Welding Society (AWS):
1. A5.1, Standard Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
  2. D1.1, Structural Welding Code Steel.
- D. Military Specifications:
1. MIL-N-25027, Nut, Self Locking, Heavy hex, (Non-Metallic Insert) 250° and 450° F, UNJC-3B, ¼" Through 2-1/2" Nominal Diameters, Nickel-Copper Alloy.
- E. American Railway Engineering and Maintenance-of-Way Association (AREMA)
1. Chapter 15 – Steel Structures

### 1.03 DEFINITIONS

- A. 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.
- B. Hardware: As defined in ASTM A153.
- C. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

### 1.04 SUBMITTALS

- A. Shop Drawings:
  - 1. See Division 01 for requirements for the mechanics and administration of the submittal process.
  - 2. Fabrication and/or layout Plans and details:
    - a. Submit Plans for all fabrications and assemblies.
      - 1) Include erection Plans, Plans, Sections, details and connection details.
- B. Miscellaneous Submittals:
  - 1. See Division 01 for requirements for the mechanics and administration of the submittal process.
  - 2. Certification of welders and welding processes.
    - a. Indicate compliance with AWS.

### 1.05 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Qualify welding procedures and welding operators in accordance with AWS.
  - 2. Fabricator shall have minimum of 10 years experience in fabrication of metal items specified.
  - 3. Engineer for contractor-designed systems and components: Professional Civil Engineer licensed in the State of California.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and handle fabrications to avoid damage.
- B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

**PART 2 - PRODUCTS****2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - 1. Headed studs and deformed bar anchors:
    - a. Nelson Stud Welding Div., TRW Inc.
    - b. Stud Welding Products, Inc.
  - 2. Expansion anchor bolts:
    - a. Hilti Inc.
    - b. ITW Ramset/Red Head.
    - c. Simpson Strongtie.
  - 3. Epoxy adhesive anchor bolts:
    - a. Hilti Inc.
    - b. ITW Ramset/Red Head.
    - c. Simpson Strongtie.
  - 4. Galvanizing repair paint:
    - a. ZRC Products.
- B. Submit request for substitution in accordance with Division 01.

**2.02 MATERIALS**

- A. Steel:
  - 1. Structural:
    - a. W-shapes and WT-shapes: ASTM A992.

- b. Plates and other rolled sections not specified above: ASTM A36.
  2. Pipe: ASTM A53, Types E or S, Grade B.
  3. Structural tubing:
    - a. ASTM A588.
  4. Bolts, nuts and washers, high strength:
    - a. ASTM A325 with ASTM A563 nuts.
    - b. Provide two (2) washers with all bolts.
  5. Machine bolts, nuts and washers:
    - a. ASTM A307 with ASTM A563 nuts.
    - b. Provide one (1) spring lock washer and two (2) plain washers with all bolts.
  6. Welding electrodes: AWS D1.1, E70 Series.
  7. Steel forgings: ASTM A668.
- B. Stainless Steel:
  1. Minimum yield strength of 30,000 psi and minimum tensile strength of 75,000 psi.
    - a. Bars, shapes: ASTM A276, Type 304.
    - b. Tubing and pipe: ASTM A276, Type 304 or 316.
    - c. Strip, plate and flat bars: ASTM A666, Type 304 or 316, Grade A.
    - d. Bolts and nuts: ASTM F594, Type 303 or 304.
  2. Minimum yield strength of 25,000 psi and minimum tensile strength of 70,000 psi.
    - a. Strip, plate and flat bar for welded connections, ASTM A666, Type 304L.
  3. Welding electrodes: In accordance with AWS for metal alloy being welded.
- C. Washers: Same material and alloy as found in accompanying bolts and nuts.
- D. Embedded Anchor Bolts:
  1. Type 304 or 316 stainless steel with two (2) matching nuts and matching washer.

2. Machine bolts with two (2) matching nuts and matching washer.
- E. Expansion Anchor Bolts and Adhesive Anchor Bolts:
1. Stainless steel, Type 304, 314 or 316.
  2. Provide minimum edge distance cover and spacing as recommended by manufacturer, or as indicated on Plans whichever is larger.
    - a. Minimum embedment as recommended by manufacturer or eight (8) diameters of bolt, whichever is larger.
    - b. Notify Engineer if required depth of embedment cannot be achieved at a particular anchor bolt location.
    - c. Follow manufacturer's recommendations for installation and torque.
  3. Provide elastic locknuts meeting the requirements of MIL-N-25027.
- F. Deformed Anchors Rods: ASTM F1554, Grade 36 with a minimum yield strength of 36,000 psi and a minimum tensile strength of 58,000 psi.
- G. Saddle Clips:
1. Meet steel grating manufacturer's recommendations.
  2. Galvanized in accordance with ASTM A153.
- H. Steel:
1. Galvanized in accordance with ASTM A123 when required to be galvanized.
- I. Steel Hardware: Galvanized in accordance with ASTM A153 or ASTM B695 when required to be galvanized.
- J. Galvanizing Repair Paint:
1. High zinc dust content paint for regalvanizing welds and abrasions.
  2. Dried film shall contain not less than 93 percent zinc dust by weight.
  3. Similar to ZRC by ZRC Products.
  4. Volatile Organic Compounds (VOC): 0 lbs per gal.

### **2.03 MANUFACTURED UNITS**

- A. Steel Checkered Plate:
1. Conform to ASTM A786.

- a. Diamond pattern: No.3 (large) or No.4 (medium).
  - b. Use one (1) pattern throughout Project.
  - c. Material: 36 ksi minimum yield strength.
- B. Steel Grating:
1. Bearing bars:
    - a. Rectangular 1-1/2" x 3/16" unless shown otherwise on Plans.
    - b. Maximum 1-3/16" OC spacing.
  2. Cross bars:
    - a. Welded to bearing bars.
    - b. Maximum 4 IN OC spacing.
  3. Top edges of bars: Serrated or grooved.
  4. Removable grating sections: Not wider than 3 feet and not more than 100 lbs unless shown otherwise on Plans.
  5. Finish:
    - a. Galvanized.
    - b. Clips and bolts: Galvanized.
    - c. Seat angles: Galvanized steel.
  6. Ends and perimeter edges: Banded.

## 2.04 FABRICATION

- A. Verify field conditions and dimensions prior to fabrication.
- B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
  1. Grind smooth all rough welds and sharp edges.
    - a. Round all corners to approximately 1/32" - 1/16" nominal radius.
- C. Provide drilled or punched holes with smooth edges.
  1. Punch or drill for field connections and for attachment of work by other trades.
- D. Weld Permanent Shop Connections:

1. Welds to be continuous fillet type unless indicated otherwise.
  2. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1.
  3. Grind smooth welds that will be exposed.
- E. Fabricate work in shop in as large assemblies as is practicable.
- F. Tolerances:
1. Rolling:
    - a. ASTM A6.
    - b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specifications.
  2. Fabrication tolerance:
    - a. Member length:
      - 1) Both ends finished for contact bearing: 1/32".
      - 2) Framed members:
        - a) 30 feet or less: 1/16".
        - b) Over 30 feet: 1/8".
    - b. Member straightness:
      - 1) ASTM A6 tolerance for wide flange shapes.
    - c. At bolted splices, depth deviation shall be taken up by filler plates.
      - 1) At welded joints, adjust weld profile to conform to variation in depth.
      - 2) Slope weld surface per AWS requirements.
    - d. Finished members shall be free from twists, bends and open joints.
      - 1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.
- G. Fabricate grating, checkered plate, and accessories using galvanized steel unless shown otherwise on Plans.

## 2.05 SOURCE QUALITY CONTROL

- A. Surface Preparation:
  - 1. Refer to Specification Section 34 80 61 for surface preparation requirements.
- B. Shop Applied Paint Coating Application:
- C. Meet structural requirements of Specification Section 34 80 51 for inspection and testing items of structural nature.
- D. Responsibilities of Testing Agency:
  - 1. Inspect shop and field welding in accordance with AWS Code, Section 6 including the following non-destructive testing:
    - a. Visually inspect all welds.
    - b. In addition to visual inspection, test 50 percent of full penetration welds and 20 percent of fillet welds with liquid dye penetrant.
    - c. Test 20 percent of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
  - 2. Inspect high-strength bolting in accordance with the AREMA Section 15.3.5.4.
  - 3. Inspect structural steel which has been erected.
  - 4. Inspect stud welding in accordance with AWS Code, Article 7.8.
  - 5. Prepare and submit inspection and test reports to Engineer.
    - a. Propose corrective measures necessary for defective work for approval by the Engineer.
- E. All items to be assembled in the field are to be shop-assembled prior to shipping.
  - 1. During assembly and reaming, all bolts shall be placed in holes as work progresses to assure proper fit.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Provide items to be built into other construction in time to allow their installation.
  - 1. If such items are not provided in time for installation, cut in and install.



- B. Prior to installation, inspect and verify condition of substrate.
  - 1. Installation of product constitutes installer's acceptance of substrate condition for product compatibility.
- C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

### 3.02 INSTALLATION

- A. Set metal work level, true to line, plumb.
  - 1. Shim and grout as necessary.
- B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.
  - 1. Plumb, align, and set structural steel members to specified tolerances.
  - 2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
  - 3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
  - 4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
    - a. If not obvious from experience or from the Plans, the Contractor shall confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
  - 5. Remove and dispose of all temporary work and facilities off-site.
- C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
  - 1. Report defects in work-in-place which may influence satisfactory completion of the work.
  - 2. Absence of such notification will be construed as acceptance of work-in-place.

- D. Field Measurement:
  - 1. Take field measurements as necessary to verify or supplement dimensions indicated on the Plans.
  - 2. Contractor responsible for the accurate fit of the work.
- E. Check the elevations of all finished pier caps and the location and alignment of all anchor bolts and bolt holes before starting erection.
  - 1. Notify Engineer of any errors or deviations found by such checking.
- F. Use light drifting necessary to draw holes together.
  - 1. Drifting to match unfair holes is not allowed.
- G. Welding:
  - 1. Conform to AWS D1.1 and requirements of Article 2.4.
  - 2. When joining two (2) sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.
- H. Shore existing members when unbolting of common connections is required.
  - 1. Use new bolts for rebolting connections.
- I. Clean stored material of all foreign matter accumulated during erection period.
- J. Bolt Field Connections: Where practicable, conceal fastenings.
- K. Grind welds smooth where field welding is required.
- L. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.
- M. Unless noted or specified otherwise:
  - 1. Connect steel members to concrete and masonry using stainless steel expansion anchor bolts.
  - 2. Provide washers for all bolted connections.
  - 3. Where exposed, bolts shall extend a maximum of  $\frac{3}{4}$ " and a minimum of  $\frac{1}{2}$ " above the top nut.
- N. Install and tighten ASTM A325 high-strength bolts in accordance with the AISC Manual of Steel Construction.
  - 1. Provide hardened washers for all ASTM A325 bolts.

- a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.
- O. After bolts are tightened, upset threads of ASTM A307 unfinished bolts or anchor bolts to prevent nuts from backing off.
- P. Secure metal to wood with lag screws of adequate size with appropriate washers.
- Q. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
  - 1. Provide full penetration welded splices where continuity is required.
- R. Provide each fabricated item complete with attachment devices as indicated or required to install.
- S. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.
  - 1. Maximum spacing: 2 feet OC with minimum of two (2) per side.
- T. Repair damaged galvanized surfaces in accordance with ASTM A780.
  - 1. Prepare damaged surfaces by abrasive blasting or power sanding.
  - 2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

### **3.03 CLEANING**

- A. After erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Metal fabrications for use in bridge 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.

### **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. Metal fabrications for use in bridge structures will be paid at the Contract Unit Price for furnishing metal fabrications and erecting metal fabrications complete in-place.
1. The contract price paid for metal fabrications shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for all work involved in constructing, furnishing, transporting, handling, and erecting units in-place as shown on the Plans, as specified in these Specifications and as directed by the Engineer.
  2. The contract price paid for metal fabrications shall include, but shall not be limited to, furnishing all bolts, nuts and washers, stud connectors, welding materials, or other materials required for the erection and connection or splicing of the metal fabrications, finishing the metal fabrications as required by these Specifications and the Plans, and conforming to the qualification and testing requirements associated with member fabrication.
  3. The contract price paid for metal fabrications shall include, but shall not be limited to, connecting and splicing the metal fabrications, installing stud connectors, furnishing and applying caulk, sealants and fillers, furnishing and placing mortar or grout for masonry or bearing plates and anchor bolts, checking bolt tension, and conforming to qualification and testing requirements associated with member erection, connection or splicing.
  4. The contract price paid for metal fabrications shall include, but shall not be limited to, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in cleaning and applying paint and protective coatings (non-metallic) and metallic coatings to metal fabrications as shown on the Plans, and as specified in these Specifications and as specified by the Engineer.

**END OF SECTION 34 80 52**

## SECTION 34 80 53

### STEEL HANDRAILS FOR RAILROAD BRIDGES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Steel handrail and guardrail.
- B. Related 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 34 80 61 - Painting and Protective Coatings for Bridges.

##### 1.02 REFERENCES

- A. ASTM International (ASTM):
  - 1. A36, Standard Specification for Carbon Structural Steel.
  - 2. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 3. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 4. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 5. A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
  - 6. A466, Standard Specification for Weldless Chain.
  - 7. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
  - 8. A489, Standard Specification for Carbon Steel Lifting Eyes.
  - 9. A563, Standard Specification for Carbon and Alloy Steel Nuts.
  - 10. A992, Standard Specification for Structural Steel Shapes.

11. A1023, Standard Specification for Stranded Carbon Steel Wire Ropes for General Purpose.
  12. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
  13. F436, Standard Specification for Hardened Steel Washers.
- B. American Railway Engineering and Maintenance-of-Way Association (AREMA):
1. Manual for Railway Engineering, Chapter 15.
- C. American Welding Society (AWS):
1. D1.1, Structural Welding Code Steel.

### 1.03 DEFINITIONS

- A. Hardware: As defined in ASTM A153.
- B. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.
- C. Handrail: A railing as defined by AREMA Chapter 15.

### 1.04 SUBMITTALS

- A. Shop Drawings:
1. See Division 01 for requirements for the mechanics and administration of the submittal process.
  2. Fabrication and/or layout Plans.
    - a. Plan showing profile, location, section and details of each railing, and type and details of anchorage system.
    - b. Location and type of expansion joints.
    - c. Materials of construction including shop-applied coatings.
  3. Product technical data including:
    - a. Acknowledgement that products submitted meet requirements of standards referenced.
    - b. Manufacturer's installation instructions.
- B. Miscellaneous Submittals:

1. See Division 01 for requirements for the mechanics and administration of the submittal process.
2. Certification of welders and welding procedures indicating compliance with AWS.
3. Certification that railings have been designed and fabricated to meet the loading requirements specified.

#### **1.05 QUALITY ASSURANCE**

- A. Qualify welding procedures and welding operators in accordance with AWS.

#### **1.06 DELIVERY, STORAGE AND HANDLING**

- A. Deliver and handle railings to preclude damage.
- B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect from corrosion.

### **PART 2 - PRODUCTS**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  1. Welded railing systems:
    - a. Any manufacturer meeting this Specification Section.
  2. Galvanizing repair paint:
    - a. ZRC Products.
- B. Submit request for substitution in accordance with Division 01.

#### **2.02 MATERIALS**

- A. Pipe: ASTM A53, Types E or S, Grade B.
- B. Steel Angle, Sheet, Bar (Pickets) and Plate: ASTM A36.
- C. Steel W and WT shapes: ASTM A992.
- D. Machine Bolts, Nuts and Washers:
  1. ASTM A307 with ASTM A563 nuts.
  2. Provide one (1) spring lock washer and two (2) plain washers with all bolts.

- E. Safety Chain and Quick Links: ASTM A466.
- F. Eyebolts: ASTM A489.
- G. Aircraft Cable: ASTM A1023.
- H. Steel: Galvanized in accordance with ASTM A123 when required to be galvanized.
- I. Steel Hardware: Galvanized in accordance with ASTM A153 or ASTM B695 when required to be galvanized.
- J. Galvanizing Repair Paint:
  - 1. High zinc dust content paint for regalvanizing welds and abrasions.
  - 2. Dried film shall contain not less than 95 percent zinc dust by weight.
  - 3. Similar to ZRC by ZRC Products.
- K. Welding Electrodes: AWS D1.1, E70 Series.
- L. Temporary Handrails:
  - 1. Material shall be either steel or timber, selected at the Contractor's discretion.
    - a. Material shall be sturdy and slip-resistant.
  - 2. Material shall be supplied by the Contractor.

### **2.03 FABRICATION**

- A. General:
  - 1. Verify field conditions and dimensions prior to fabrication.
  - 2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
    - a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
  - 3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
    - a. Ease exposed edges to a radius of approximately 1/32".
    - b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.



4. Form exposed connections by welding.
  5. Provide for anchorage of type indicated on the Plans.
    - a. Drill or punch holes with smooth edges.
  6. Custom fabricate pipe railings to dimensions and profiles indicated.
    - a. Fabricate guardrail vertical posts using 1-1/2" nominal diameter Schedule 40 pipe.
    - b. Fabricate all guardrail top rails using 1-1/2" nominal diameter Schedule 40 pipe.
    - c. All intermediate rails shall be fabricated using minimum 1-1/2" nominal diameter Schedule 40 pipe.
  7. Fit exposed ends of handrails with solid terminations.
  8. The ends of handrails shall not overhand terminal posts except where such overhang does not constitute a projection hazard.
  9. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.
- B. Finish: Galvanized after fabrication, unless shown otherwise in the Plans.
- C. Welded Railing Fabrication:
1. All welding to be continuous in accordance with AWS D1.1.
    - a. All welded railing joints shall have full penetration welds.
  2. All exposed welds to be ground and buffed smooth and flush to match and blend with adjoining surfaces.
  3. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.
- D. Install weeps to drain moisture from hollow sections of railing at exterior locations and in high humidity areas.
1. Drill 3/8" vent in railings at each end of horizontal pipes.
- E. Expansion Joints:
1. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.
    - a. Top rail splices and expansion joints shall be located within 8 IN of post or other support.

- b. Where railings span structure expansion joints; provide a railing expansion joint in the span crossing the structure expansion joint.
2. Provide expansion joints in any continuous run exceeding 20 feet in length.
  - a. Space expansion joints at not more than 40 feet OC.
3. Provide minimum 0.10 inches of expansion joint for each 20 feet length of top rail for each 25° F differential between installation temperature and maximum design temperature.
  - a. Maximum expansion joint width at time of installation shall not exceed 3/8".
    - 1) Provide additional expansion joints as required to limit expansion joint width.
4. Provide slip-joint with internal sleeve.
  - a. Extend slip joint min 2 inches beyond joint at maximum design width.
  - b. Fasten internal sleeve securely to one side
    - 1) Provide allen-head set screw located in bottom of rail.
    - 2) Rivets or exposed screw heads are not acceptable.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Prior to installation, inspect and verify condition of substrate.
  1. Installation of product constitutes installer's acceptance of substrate condition for product compatibility.
- B. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

### **3.02 TEMPORARY HANDRAILS**

- A. Temporary handrails shall be installed where necessary to provide fall protection during construction.
- B. The top edge height of the top rail shall be 42 inches ±3 inches above the walking/working surface.
- C. At least two midrails shall be provided, evenly spaced between the walking/working surface and the top rail.

- D. Temporary handrail posts shall be placed at a maximum of 10 feet intervals.
- E. Entire handrail system, including anchorages, shall be capable of withstanding without failure, a force of 200 lbs applied in any outward or downward direction at any point.
- F. Handrail system shall be surfaced to prevent injuries from punctures or laceration and prevent snagging of clothing. The ends of top rails and midrails shall not extend past the posts.
- G. If conditions warrant, additional protection shall be provided such as screens or mesh to prevent slipping between the midrails and the walking/working surface.

### 3.03 INSTALLATION

- A. Install products in accordance with Plans.
- B. Set work accurately in location, alignment and elevation; plumb, level, and true.
- C. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.
  - 1. Provide shims as required.
- D. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer.
  - 1. Lubricate expansion joint splice bar for smooth movement of railing sections.
- E. Attach handrails to walls or guardrails with brackets designed for condition.
  - 1. Anchor handrail to concrete with  $\frac{3}{4}$ " heavy hex ASTM A307 bolt with washer and heavy weight elastic locknut.
- F. Anchor railings to metal structure with minimum  $\frac{5}{8}$ " high strength steel bolts, nuts and washers.
- G. Repair damaged galvanized surfaces in accordance with ASTM A780.
  - 1. Properly prepare surface in accordance with galvanizing repair paint manufacturer's recommendations.
  - 2. Apply minimum 6 mils DFT of galvanizing repair paint in accordance with manufacturer's recommendations.
- H. Prepare and paint railings in accordance with Specification Section 34 80 61.

## **PART 4 - MEASUREMENT AND PAYMENT**

### **4.01 MEASUREMENT**

- A. Steel handrails for use in bridge 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. Steel handrails for use in bridge structures will be measured from end to end along the face of the railing, including end and intermediate posts, and with no deductions for gaps in railing for lighting and sign supports. The measurement shall be made along the face of the rail elements without allowance for overlap at rail splices.

### **4.02 PAYMENT**

- A. Steel handrails for use in bridge 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. Steel handrails for use in bridge structures will be paid at the Contract Unit Price for furnishing steel handrails and erecting steel handrails complete in-place.
  - 1. The contract price paid for steel handrails shall include, but shall not be limited to, furnishing all bolts, nuts and washers, welding materials, or other materials required for the erection and connection or splicing of the steel handrails, finishing the steel handrails as required by these Specifications and the Plans, and conforming to the qualification and testing requirements associated with member fabrication.
  - 2. The contract price paid for steel handrails shall include, but shall not be limited to, connecting and splicing the steel handrails, installing end treatments, anchor assemblies, and return and end caps, furnishing and placing mortar or grout anchor bolts, checking bolt tension, and conforming to qualification and testing requirements associated with member erection, connection or splicing.
  - 3. The contract price paid for steel handrails shall include, but shall not be limited to, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in cleaning and applying paint and protective coatings (non-metallic) and metallic coatings to steel handrails as shown on the Plans, and as specified in these Specifications and as specified by the Engineer.

**END OF SECTION 34 80 53**

## SECTION 34 80 61

### PAINTING AND PROTECTIVE COATINGS FOR RAILROAD BRIDGES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
1. High performance industrial coatings (HPIC).
  2. Any other coating, thinner, accelerator, inhibitor, and any other material, specified or required as part of a complete System specified in this Specification Section.
  3. Minimum surface preparation requirements.
- 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 Concrete.
  5. Section 34 80 52 - Metal Fabrications For Railroad Bridges.
  6. Section 34 80 53 - Steel Handrails For Railroad Bridges.

##### 1.02 REFERENCES

- A. Reference Standards:
1. ASTM International (ASTM):
    - a. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
    - b. D4259, Standard Practice for Abrading Concrete.
    - c. D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
    - d. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.

- e. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
2. National Bureau of Standards (NBS):
  - a. Certified Coating Thickness Calibration Standards.
3. The Society for Protective Coatings (SSPC):
  - a. PA 2, Measurement of Dry Paint Thickness with Magnetic Gages.
  - b. SP 1, Solvent Cleaning.
4. The Society for Protective Coatings/NACE International (SSPC/NACE):
  - a. SP 5/NACE No. 1, White Metal Blast Cleaning.
  - b. SP 6/NACE No. 3, Commercial Blast Cleaning.
  - c. SP 7/NACE No. 4, Brush-off Blast Cleaning.
  - d. SP 10/NACE No. 2, Near-White Blast Cleaning.
  - e. SP 12/NACE No. 5, Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
  - f. SP 13/NACE No. 6, Surface Preparation of Concrete.
- B. Miscellaneous:
  1. Furnish coating material through one (1) manufacturer unless noted otherwise.
- C. Deviation from specified mil thickness or product type is not allowed without written authorization of Engineer.
- D. Material shall not be thinned unless approved, in writing, by coating material manufacturer's authorized representative.

### 1.03 DEFINITIONS

- A. 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.
- B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified.

- C. Corrosive Environment: Immersion in, or not more than 6 inches above, or subject to condensation, spillage or splash of a corrosive material such as water, wastewater, or chemical solution; or exposure to corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range of 5 to 9.
- D. Highly Corrosive Environment: Immersion in, or not more than 6 inches above, or subject to condensation, spillage or splash of a highly corrosive material such as water, wastewater, or chemical solution; or exposure to highly corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range below five (5) or above nine (9).
- E. Exposed Exterior Surface:
  - 1. Surface which is exposed to weather but not necessarily exposed to view as well as surface exposed to view.
  - 2. Exterior surfaces are considered corrosive environment.
    - a. The following areas are considered highly corrosive:
      - 1) All chemical unloading stations and areas within 10 feet-0 inches of containment areas.
      - 2) All chemical unloading station containment areas.
      - 3) All areas within a 6 feet radius of chemical tank vents.
      - 4) All areas within 1 mile of coast.
- F. Finished Area: An area that is indicated on Drawings to be painted.
- G. Immersion Surface:
  - 1. Any surface immersed in water or some other liquid.
  - 2. Surface of any pipe, valve, or any other component of the piping system subject to condensation including the pipe support system.
- H. Paint includes the following:
  - 1. High performance industrial coatings (HPIC) include: Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.
- I. Surface Hidden from View: Surfaces such as those within pipe chases and surfaces under overhanging walkways if over 5 feet above adjacent walking surfaces
- J. HPIC: High performance industrial coatings.
- K. Water level for purposes of painting: See Drawings.

**1.04 SUBMITTALS**

- A. Shop Drawings:
1. See Division 01 for requirements for the mechanics and administration of the submittal process.
  2. Applicator experience qualifications.
    - a. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.
  3. Product technical data including:
    - a. Acknowledgement that products submitted meet requirements of standards referenced.
    - b. Manufacturer's application instructions.
    - c. Manufacturer's surface preparation instructions.
    - d. If products being used are manufactured by Company other than listed in Article 2.02 - MATERIALS, provide complete individual data sheet comparison of proposed products with specified products including application procedure, coverage rates and verification that product is designed for intended use.
    - e. Contractor's written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
    - f. Coating manufacturer's recommendation on abrasive blasting.
    - g. Manufacturer's recommendation for universal barrier coat.
    - h. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.
  4. Manufacturer's statement regarding applicator instruction on product use.
  5. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by Senior Corrosion Specification Specialist employed by the coating manufacturer.
- B. Samples:
1. Manufacturer's full line of colors for Engineer's preliminary color selection.
  2. After preliminary color selection by Engineer provide two (2) 3 x 5 inches samples of each final color selected.



- C. Miscellaneous Submittals:
1. See Division 01 for requirements for the mechanics and administration of the submittal process.
  2. Approval of application equipment.
  3. Applicator's daily records:
    - a. Submit daily records at end of each week in which painting work is performed unless requested otherwise by Engineer's on-site representative.

### **1.05 QUALITY ASSURANCE**

- A. Qualifications:
1. Coating manufacturer's authorized representative shall provide written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.
  2. Applicators shall have minimum of 10 years experience in application of similar products on similar project.
    - a. Provide references for minimum of three (3) different projects completed in last five (5) years with similar scope of work.
    - b. Include name and address of project, size of project in value (painting) and contact person.

### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver in original containers, labeled as follows:
1. Name or type number of material.
  2. Manufacturer's name and item stock number.
  3. Contents, by volume, of major constituents.
  4. Warning labels.
  5. Volatile Organic Compound (VOC) content.

**PART 2 - PRODUCTS****2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - 1. High performance industrial coatings:
    - a. Tnemec.
    - b. Tiger DrylaC.
    - c. Sherwin Williams.
    - d. Diamond Vogel/Perdium.
    - e. International.
  - 2. Graffiti-resistant coating:
    - a. Pro SoLo.
- B. Submit request for substitution in accordance with Division 01.
  - 1. Product VOC content will be an important factor when determining acceptability of substitution.

**2.02 MATERIALS**

- A. For unspecified materials such as thinner, provide manufacturer's recommended products.
- B. Paint Systems - General:
  - 1. P = prime coat.
  - 2. F1, F2 . . . Fn = first finish coat, second finish coat . . . nth finish coat, color as selected by Engineer.
  - 3. If two (2) finish coats of same material are required, Contractor may, at his option and by written approval from paint manufacturer, apply one (1) coat equal to mil thickness of two (2) coats specified.
- C. HPIC products listed in Article 2.02 - MATERIALS, Paragraph E. Paint Systems are manufactured by Tnemec.

1. Products of other listed manufacturers are acceptable for use providing the product is of the same generic resin, requires comparable surface preparation, has comparable application requirements, meets the same VOC levels or better, provides the same finish and color options and will withstand the atmospheric conditions of the location where it is to be applied.

D. Paint Systems (Systems not shown are not used):

1. HPIC SYSTEM #1 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Finish Coat(s).
  - a. Prime coat:
    - 1) P1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
  - b. Finish coat(s):
    - 1) Interior:
      - a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      - b) F2 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
    - 2) Exterior:
      - a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      - b) F2 = 1 coat, 2.5 mils, Series 1080 Endura-Shield. W.B.(Waterborne Acrylic Polyurethane).
2. HPIC SYSTEM #2 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
  - a. Prime coat:
    - 1) P1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
  - b. Finish coat(s):
    - 1) Interior:
      - a) F1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
    - 2) Exterior:

- a) F1 = 1 coat, 2.5 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).
3. HPIC SYSTEM #3 - Zinc-Rich Urethane Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
    - a. Prime coat:
      - 1) P1 = 1 coat, 2.5 mils, Series 90-97 Tneme-Zinc (Zinc-Rich Urethane).
    - b. Finish coat(s):
      - 1) Interior:
        - a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      - 2) Exterior:
        - a) F1 = 1 coat, 2.5 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).
  4. HPIC SYSTEM #4 - Modified Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
    - a. Prime coat:
      - 1) P1 = 1 coat, 3 mils, Series 135 Chembuild (Modified Polyamidoamine Epoxy).
    - b. Finish coat(s):
      - 1) Interior:
        - a) F1 = 1 coat, 4 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      - 2) Exterior:
        - a) F1 = 1 coat, 3 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).
  5. HPIC SYSTEM #5 - Zinc-Rich Urethane Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
    - a. Prime coat:
      - 1) P1 = 1 coat, 2.5 mils, Series 90-97 Tneme-Zinc (Zinc-Rich Urethane).

- b. Finish coat(s):
  - 1) Interior:
    - a) F1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
  - 2) Exterior:
    - a) F1 = 1 coat, 3.0 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).
- 6. HPIC SYSTEM #6 - Modified Polyamidoamine Epoxy.
  - a. Prime coat:
    - 1) P1 = 1 coat, 3 mils, Series 135 Chembuild (Modified Polyamidoamine Epoxy).
- 7. HPIC SYSTEM #7 - Zinc-Rich Aromatic Urethane Primer.
  - a. Prime coat:
    - 1) P1 = 1 coat, 3.0 mils, 90-97 Tneme-Zinc (Zinc-Rich Urethane).
- 8. HPIC SYSTEM #8 - Modified-Acrylate Elastomer Primer and Top Coat.
  - a. Prime coat:
    - 1) P1 = 1 coat, 8 mils, Series 156 Enviro-Crete (Modified-Acrylate Elastomer).
  - b. Finish coat:
    - 1) Exterior:
      - a) F1 = 1 coat, 8 mils, Series 156 Enviro-Crete (Modified-Acrylate Elastomer).
- 9. HPIC SYSTEM #9 - Acrylic Emulsion Primer with Acrylic Emulsion Top Coat(s).
  - a. Prime coat:
    - 1) P1 = 1 coat, 60 to 90 SF/GAL/coat, Series 180 W.B. Tneme-Crete (Acrylic Emulsion).

- b. Finish coat(s):
  - 1) Exterior:
    - a) F1 = 1 coat, 125 to 150 SF/GAL/coat, Series 180 W.B. Tneme-Crete (Acrylic Emulsion).
- 10. HPIC SYSTEM #10 - Polyamidoamine Epoxy Coating.
  - a. Prime coat:
    - 1) P1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
- 11. HPIC SYSTEM #11 - Modified Polyamidoamine Epoxy.
  - a. Prime coat:
    - 1) P1 = 1 coat, 5 mils, 135-1243 Chembuild (Modified Polyamidoamine Epoxy).
- 12. HPIC SYSTEM #12 - Waterborne Acrylic Emulsion Prime and Top Coats.
  - a. Prime coat:
    - 1) P1 = 1 coat, 80 to 110 SF/GAL/coat, Series 180, W.B. Tneme-Crete (Acrylic Emulsion).
  - b. Finish coat:
    - 1) Exterior:
      - a) F1 = 1 coat, 175 to 200 SF/GAL/coat, Series 180, W.B. Tneme-Crete (Acrylic Emulsion).
- 13. HPIC SYSTEM #13 - Waterborne Cementitious Acrylic Patching Compound/Filler with Polyamidoamine Epoxy Top Coat.
  - a. Patching/filling coat:
    - 1) P/F1 = 1 coat, 60 to 80 SF/GAL/coat, Series 130 Envirofill (Waterborne Cementitious Acrylic).
  - b. Finish coat:
    - 1) Interior:
      - a) F1 = 1 coat, 175 to 200 SF/GAL/coat, Series L69 Epoxoline (Polyamidoamine Epoxy).
      - b) F2 = 1 coat, 175 to 200 SF/GAL/coat, Series L69 Epoxoline (Polyamidoamine Epoxy).

14. HPIC SYSTEM #14 - Waterborne Vinyl Acrylic Primer with Water-base Acrylic-Emulsion Top Coat.
  - a. Prime coat(s):
    - 1) P1 = 1 coat, 2.0 mils, Series 51-792 PVA Sealer.
  - b. Finish coat(s):
    - 1) Interior and exterior:
      - a) F1 = 1 coat, 2.5 mils, Series 6 Tneme-Cryl.
15. HPIC SYSTEM #15 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy Top Coat (with silica sand broadcast for slip resistance).
  - a. Prime coat:
    - 1) P1 = 1 coat, 5 mils, Series L69 Epoxoline II.
  - b. Slip resistance:
    - 1) Blend dry, washed 30 to 50 mesh silica sand into first finish coat (F1) at rate required to provide a heavy slip resistant finish.
  - c. Finish coat:
    - 1) F1 = 1 coat, 4 mils, Series L69 Epoxoline II.
    - 2) F2 = 1 coat, Series L69 Epoxoline II.
      - a) F2 coat mil thickness is to be as required to achieve non-slip texture specified.
16. HPIC SYSTEM #16 - Polyamine Novolac Epoxy Primer with Polyamine Novolac Epoxy Top Coat.
  - a. Prime coat:
    - 1) P1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
    - 2) P1 (vertical surface) = 1 coat, 8 to 10 mils, Series 282 Tneme-Glaze.
  - b. Finish coat:
    - 1) F1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.

- 2) F1 (vertical surface) = 1 coat, 8 to 10 mils, Series 282 Tneme-Glaze.
17. HPIC SYSTEM #17 - Epoxy Modified Surfacer/Filler with Polyamine Novolac Epoxy Top Coats.
    - a. Filler/surfacer coat:
      - 1) Filler = 1 coat, 0.0625 IN thick, Series 218 Mortar Clad.
    - b. Prime coat:
      - 1) P1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      - 2) P1 (vertical surface) = 1 coat, 6 to 8 mils, Series 282 Tneme-Glaze.
    - c. Finish coat:
      - 1) F1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      - 2) F1 (vertical surface) = 1 coat, 6 to 8 mils, Series 282 Tneme-Glaze.
  18. SYSTEM #18 - Touch-up of galvanized surfaces not requiring a top coat.
    - a. Refer to Specification Section 34 80 52.
  19. SYSTEM # 19 - Epoxy Paint.
    - a. Finish coat:
      - 1) F1 = 1 coat, 10 mils dry film thickness, International Interzone 954, color to be selected by SCRRA.  
F2 = 1 coat, 10 mils dry film thickness, International interzone 954, color to be selected by SCRRA.

## **PART 3 - EXECUTION**

### **3.01 ITEMS TO BE PAINTED**

- A. Exposed Surfaces indicated on Drawings.
  1. Conduit, device boxes, junction boxes and covers, pull boxes and covers and supports when attached to a surface required to be painted or to a prefinished surface.
  2. Miscellaneous ferrous metal surfaces.



3. Structural steel.

### 3.02 ITEMS NOT TO BE PAINTED

- A. General: Do not paint items listed in this Article unless specifically noted in the Contract Documents to be painted.
- B. Items with Approved Factory Finish: These items may require repair of damaged painted areas or painting of welded connections.
- C. Electrical Equipment:
  1. Do not field paint electrical equipment except where painting is specifically stated elsewhere in these Contract Documents, or where the equipment is subject to a corrosive environment and is specifically noted to be painted.
- D. When not in a corrosive or highly corrosive area, do not paint the following hidden surfaces:
  1. Concrete and/or concrete masonry units.
  2. Conduit.
  3. Galvanized metal surfaces.
  4. Note: Manufacturer's standard coatings, if any, may remain.
- E. Other Items:
  1. Stainless steel surfaces except:
    - a. Piping where specifically noted to be painted.
    - b. Banding as required to identify piping.
  2. Code labels and equipment identification and rating plates.
  3. Concealed surfaces of precolored masonry.
  4. Steel deck, unless specifically noted to be painted in the Contract Documents.
  5. Contact surfaces of friction-type connections.
  6. Metal soffit.
  7. Galvanized steel items, unless specifically noted to be painted.

**3.03 SCHEDULE OF ITEMS TO BE PAINTED AND PAINTING SYSTEMS**

- A. Concrete:
  - 1. Cast-in-place and precast surfaces (other than prefinished panels): SYSTEM #8.
- B. Concrete Masonry Units:
  - 1. Exterior smooth faced standard (heavy) weight: SYSTEM #12.
  - 2. Exterior rough faced standard (heavy) weight: SYSTEM #9.
- C. Steel:
  - 1. Structural:
    - a. Exposed portion of pile plate, piling between the pile plates and concrete collars or ground line, angle bracing and any other non-galvanized exposed steel: SYSTEM #19.
    - b. Immersion or non-immersion surfaces subject to highly corrosive environment: SYSTEM #19.
    - c. Non-immersion surfaces subject to corrosive environment: SYSTEM #1.
    - d. All other surfaces (non-corrosive dry environment): SYSTEM #5.
- D. Miscellaneous ferrous metals (non-corrosive dry environment): SYSTEM #1.
  - 1. Not for coating galvanized steel and products with approved factory finishes.
- E. Galvanized Metals:
  - 1. Field touch-up where top coat is required: SYSTEM #2, prime and first finish coat only.
    - a. Prime paint only the damaged area.
  - 2. Assembled galvanized steel items: SYSTEM #2.
  - 3. Field touch-up of galvanized surfaces not requiring a finish top coat: SYSTEM #18.
    - a. Paint only damaged areas.
- F. Non-ferrous metals (except galvanized): SYSTEM #2.
  - 1. Includes copper, brass, aluminum and aluminum flashing specifically indicated on the Drawings to be painted.

- G. Electrical Conduit:
  - 1. Galvanized: SYSTEM #2.
  - 2. PVC coated: SYSTEM #2.
- H. Aluminum buried in concrete, between dissimilar metals and dissimilar materials: SYSTEM #10.
- I. Aluminum colored pipe thread touch-up, and aluminum colored finish where top coat is not required: SYSTEM #11.
  - 1. Not for coating aluminum material.

### 3.04 PREPARATION

- A. General:
  - 1. Verify that atmosphere in area where painting is to take place is within paint manufacturer's acceptable temperature, humidity and sun exposure limits.
    - a. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
      - 1) Provide temporary dehumidification equipment properly sized to maintain humidity levels required by paint manufacturer.
      - 2) Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 hours basis.
      - 3) No exhaust gases (no direct fired heating equipment) shall be allowed to vent into the space being painted or any adjacent space.
  - 2. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
    - a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Engineer.
  - 3. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.

4. Adhere to manufacturer's recoat time surface preparation requirements.
  - a. Paint manufacturer's recommended recoat time surface preparation requirements will be strictly enforced.
- B. Protection:
  1. Protect surrounding surfaces not to be coated.
  2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
- C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.
- D. Ferrous Metal:
  1. Prepare ductile iron pipe in accordance with pipe manufacturer's recommendations.
  2. Complete fabrication, welding or burning before beginning surface preparation.
    - a. Chip or grind off flux, spatter, slag or other laminations left from welding.
    - b. Remove mill scale.
    - c. Grind smooth rough welds and other sharp projections.
  3. Solvent or water jet and detergent clean in accordance with SSPC SP 1 or SSPC SP 12/NACE No. 5 all surfaces scheduled to receive additional SSPC surface preparation.
  4. Surfaces subject to corrosive or highly corrosive environment and all surfaces subject to immersion service:
    - a. Near-white blast clean in accordance with SSPC SP 10/NACE No. 2.
  5. All interior and exterior structural steel not included in corrosive, highly corrosive or immersion service surfaces:
    - a. Minimum commercial blast clean in accordance with SSPC SP 6/NACE No. 3.
  6. Steel surfaces scheduled to receive SYSTEM #16:
    - a. White metal blast clean in accordance with SSPC SP 5/NACE No. 1.
    - b. Provide 2-1/2 to 3 mil anchor profile.

7. All fusion bonded epoxy coated surfaces identified to be field painted:
    - a. Remove all traces of gloss finish by sanding or by abrasive brush blasting.
    - b. Clean surface after removing gloss finish to remove sanding or blasting residue.
  8. Restore surface of field welds and adjacent areas to original surface preparation.
- E. Hollow Metal:
1. Clean in accordance with SSPC SP 1 or SSPC SP 12/NACE No. 5 and in accordance with hollow metal manufacturer.
- F. Galvanized Metal:
1. Solvent clean in accordance with SSPC SP 1 followed by brush-off blast clean in accordance with SSPC SP 7/NACE No. 4 to uniform profiled surface removing zinc oxide and other foreign contaminants.
    - a. Provide 1 mil profile.
- G. Concrete:
1. Cure for minimum of 28 days.
  2. Verify that concrete surfaces have been cleaned and that voids have been patched in accordance with Specification Section 34 80 41 or Section 34 80 43.
    - a. Concrete surfaces shall be cleaned in accordance with ASTM D4258.
  3. Mechanically abrade concrete surfaces in accordance with ASTM D4259 as recommended by coating manufacturer.
  4. Abrasive blast concrete surfaces in accordance with SSPC SP 13/NACE No. 6 to provide profile recommended by coatings manufacturer.
  5. Test pH of surface to be painted in accordance with ASTM D4262.
    - a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable range.
    - b. Retest pH until acceptable results are obtained.

6. Verify that moisture content of surface to be painted is within coating manufacturer's recommended acceptable limits.
  - a. Test moisture content of surface to be coated in accordance with ASTM D4263.
  - b. After remedial measures have been taken to lower or raise moisture content, retest surface until acceptable results are obtained.
  
- H. Concrete Masonry Unit:
  1. Cure for minimum of 28 days.
  2. Remove all mortar spatters and protrusions.
  3. Verify that concrete unit masonry surfaces have been cleaned in accordance with ASTM D4261.
  4. Test pH of surface to be painted in accordance with ASTM D4262.
    - a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable limits.
    - b. Retest pH until acceptable results are obtained.
  5. Verify that moisture content of surface to be painted is within coating manufacturer's recommended acceptable limits.
    - a. Test moisture content of surface to be coated in accordance with ASTM D4263.
    - b. After remedial measures have been taken to lower or raise moisture content, retest surface until acceptable range is obtained.
  
- I. Preparation by Abrasive Blasting:
  1. All abrasive-blasted ferrous metal surfaces shall be inspected immediately prior to application of paint coatings.
    - a. Inspection shall be performed to determine cleanliness and profile depth of blasted surfaces and to certify that surface has been prepared in accordance with these Specifications.
  2. Schedule the abrasive blasting operation so blasted surfaces will not be wet after blasting and before painting.
  3. Perform additional blasting and cleaning as required to achieve surface preparation required.
    - a. Prior to painting, reblast surfaces allowed to set overnight and surfaces that show rust bloom.

- b. Surfaces allowed to set overnight or surfaces which show rust bloom prior to painting shall be reinspected prior to paint application.
  4. Profile depth of blasted surface: Not less than 1 mil or greater than 2 mils unless required otherwise by coating manufacturer.
  5. Provide compressed air for blasting that is free of water and oil.
    - a. Provide accessible separators and traps.
  6. Confine blast abrasives to area being blasted.
    - a. Provide shields of polyethylene sheeting or other such barriers to confine blast material.
    - b. Plug pipes, holes, or openings before blasting and keep plugged until blast operation is complete and residue is removed.
  7. Protect nameplates and other items that may be damaged from blasting.
  8. Reblast surfaces not meeting requirements of these Specifications.
  9. Abrasive blasting media may be recovered, cleaned and reused providing Contractor submits, for Engineer's review, a comprehensive recovery plan outlining all procedures and equipment proposed in reclamation process.
  10. Properly dispose of blasting material contaminated with debris from blasting operation not scheduled to be reused.
- J. All Non-Ferrous Surfaces Except Galvanized Steel:
  1. Sand using 80-100 grit sandpaper to scarify surfaces.

### **3.05 APPLICATION**

- A. General:
  1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
    - a. Application equipment must be inspected and approved in writing by coating manufacturer.
    - b. Hollow metal shall be spray applied only.
  2. Temperature and weather conditions:

- a. Do not paint surfaces when surface temperature is below 50° F unless product has been formulated specifically for low temperature application and application is approved in writing by Engineer and paint manufacturer's authorized representative.
  - b. Avoid painting surfaces exposed to hot sun.
  - c. Do not paint on damp surfaces.
3. Immediately after surface has been inspected apply structural steel and miscellaneous steel prime coat in the factory.
- a. Finish coats shall be applied in the field.
  - b. Prime coat referred to here is prime coat as indicated in this Specification.
    - 1) Structural steel and miscellaneous steel prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.
4. Provide complete coverage to mil thickness specified.
- a. Thickness specified is dry mil thickness.
  - b. All paint systems are "to cover." In situations of discrepancy between manufacturer's square footage coverage rates and mil thickness, mil thickness requirements govern.
  - c. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.
5. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.
6. Apply materials under adequate illumination.
7. Evenly spread to provide full, smooth coverage.
8. Work each application of material into corners, crevices, joints, and other difficult to work areas.
9. Avoid degradation and contamination of blasted surfaces and avoid intercoat contamination.
- a. Clean contaminated surfaces before applying next coat.
10. Smooth out runs or sags immediately, or remove and recoat entire surface.
11. Allow preceding coats to dry before recoating.



- a. Recoat within time limits specified by coating manufacturer.
  - b. If recoat time limits have expired re-prepare surface in accordance with coating manufacturer's printed recommendations.
12. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
  13. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating to work into all recesses.
  14. Backroll concrete and masonry surfaces with a roller if paint coatings are spray applied.
- B. Prime Coat Application:
1. Prime all surfaces indicated to be painted.
    - a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.
  2. Ensure field-applied coatings are compatible with factory-applied coatings.
    - a. Employ services of coating manufacturer's qualified technical representative.
      - 1) Certify through material data sheets.
      - 2) Perform test patch.
    - b. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
    - c. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate paint system listed in Article 2.02 - MATERIALS, Paragraph D. Paint Systems.
      - 1) All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to SCRRA.
  3. Prime ferrous metals embedded in concrete to minimum of 1 IN below exposed surfaces.
  4. Apply zinc-rich primers while under continuous agitation.
  5. Ensure abrasive blasting operation does not result in embedment of abrasive particles in paint film.

6. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.
  7. Touch up damaged primer coats prior to applying finish coats.
    - a. Restore primed surface equal to surface before damage.
- C. Finish Coat Application:
1. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
  2. Touch up damaged finish coats using same application method and same material specified for finish coat.
    - a. Prepare damaged area in accordance with Article 3.04 - PREPARATION.

### **3.06 GRAFFTI-RESITANT COATING**

- A. All accessible concrete, masonry, and porous surfaces from finish grade to 10 feet above finish grade shall be painted with clear graffiti-resistant coating.
- B. Surface Preparation:
1. Prepare surfaces to receive the coating in compliance with the coating manufacturer's written instructions.
- C. Coating Preparations:
1. Only open containers required for use.
    - a. Mix coating in designated areas.
    - b. If mixing areas are not designated, Contractor must propose mix area to the Engineer for Engineer's acceptance.
  2. Thoroughly stir and agitate coating to uniformly smooth consistency suitable for proper application.
  3. Do not reduce, change or use materials except in compliance with manufacturers written instructions.
  4. In all cases, prepare and handle coating to prevent deterioration and inclusion of foreign matter.

- D. Application:
1. Test coating on each type of substrate for compatibility and desired results before proceeding further.
  2. Apply coating only under conditions that will ensure finishes free from blemishes and defects.
  3. Remove spillage and splatters on adjacent surfaces so as not to damage the surface being cleaned.
  4. Completed work shall match approved samples, as determined by the Engineer.

### 3.07 FIELD QUALITY CONTROL

- A. Contractor to provide protection for surfaces painted with epoxy coatings to prevent chalking.
1. Surfaces showing chalking will not be accepted regardless of condition of paint film.
- B. Maintain Daily Records:
1. Provide the following information during application of each coat of paint applied:
    - a. Date, starting time, end time, and all breaks taken by painters.
    - b. For exterior painting:
      - 1) Sky condition.
      - 2) Wind speed and direction.
    - c. Air temperature.
    - d. Relative humidity.
    - e. Moisture content of substrate prior to each coat.
    - f. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind blown dust and debris from contaminating the wet paint film.
    - g. Surface temperature of substrate to which paint is being applied.

2. Provide the following information daily for the paint manufacturer's recommended curing period:
    - a. Start date of cure period for each item or area.
    - b. For exterior painting:
      - 1) Sky conditions.
      - 2) Wind speed and direction.
    - c. Air temperature, each day.
    - d. Relative humidity, each day.
    - e. Dew point temperature, each day.
    - f. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.
  3. Format for daily record to be computer generated.
- C. Measure wet coating with wet film thickness gages.
- D. Measure coating dry film thickness in accordance with SSPC PA 2 using Mikrotest gage calibrated against NBS "Certified Coating Thickness Calibration Standards."
1. Engineer may measure coating thickness at any time during project to assure conformance with these Specifications.
- E. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.
- F. Measure substrate humidity with humidity gage specifically designed for such.

### **3.08 CLEANING**

- A. Clean paint spattered surfaces.
  1. Use care not to damage finished surfaces.
- B. Upon completion of painting, replace hardware, accessories, plates, fixtures, and similar items.
- C. Remove surplus materials, scaffolding, and debris.

**PART 4 - MEASUREMENT AND PAYMENT****4.01 MEASUREMENT**

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 34 80 61**