

## SECTION 34 21 70

### TRACTION POWER FACILITIES INSTALLATION REQUIREMENTS

#### PART 1 – GENERAL

##### 1.01 SECTION INCLUDES

- A. Traction Power Equipment.
- B. Underground Ductbanks.
- C. Precast Structures and Covers.
- D. Cast-In-Place Structures.
- E. Cable Trench Covers and Gratings.
- F. Grounding and Bonding.
- G. Storm Water, Sewage and Water Lines.
- H. Site Finish.
- I. Perimeter Security Barrier.
- J. Gates.
- K. Exterior Light Fixtures.
- L. Blue Light Stations.
- M. Communications Equipment.
- N. Sump Pumps and Associated Controllers.
- O. Failsafe to Close Drain Valve with Oil Detection Materials.
- P. Wiring Devices.
- Q. Static Signage.
- R. Conduit, Cable Trays and Boxes.
- S. Cables and Wires.
- T. Cable Splice and Termination.
- U. Identification
- V. Fire Proofing/Barriers

**1.02 RELATED SECTIONS**

A. Refer to the following Sections for requirements relating to inspection and testing activities:

1. Section 01 11 00 Summary of Work
2. Section 01 33 00 Submittal Procedures
3. Section 01 33 23 Shop Drawings, Product Data, and Samples
4. Section 01 35 14 Operating System Interface
5. Section 01 43 00 Quality Assurance
6. Section 01 45 00 Quality Control
7. Section 01 60 00 Product Requirements
8. Section 01 71 13 Mobilization
9. Section 01 74 14 Cleaning
10. Section 01 77 00 Closeout Procedures
11. Section 01 78 39 Project Record Documents
12. Section 03 05 15 Portland Cement Concrete
13. Section 03 11 00 Concrete Forming
14. Section 03 20 00 Concrete Reinforcing
15. Section 03 30 00 Cast-In-Place Concrete
16. Section 04 22 00 Concrete Unit Masonry
17. Section 05 50 00 Metal Fabrications
18. Section 07 84 00 Firestopping
19. Section 20 50 13 Raceways for Facility Services
20. Section 20 50 16 Underground Ductwork and Structures for Facility Services
21. Section 20 70 26 Common Materials and Methods for Electrical Systems
22. Section 22 11 01 Water Distribution
23. Section 22 13 01 Sanitary Sewerage

TRACTION POWER FACILITIES INSTALLATION REQUIREMENTS

24. Section 22 14 01 Storm Drainage
25. Section 22 14 29 Sump Pumps
26. Section 26 05 24 Low Voltage Wires and Cables
27. Section 26 50 00 Lighting
28. Section 27 13 01 Communication Cables and Related Equipment
29. Section 28 10 01 Access Control Systems
30. Section 28 41 29 Closed Circuit Television System
31. Section 31 23 19 Dewatering
32. Section 32 11 24 Aggregate Drainage Layer
33. Section 32 31 13 Chain Link Fences and Gates
34. Section 33 05 16 Utility Structures
35. Section 33 05 28 Trenching and Backfilling for Utilities
36. Section 33 11 00 Water Utility Distribution Piping
37. Section 33 31 00 Sanitary Utility Sewerage Piping
38. Section 33 40 00 Storm Drainage Utilities
39. Section 33 46 00 Subdrainage
40. Section 34 21 01 General Requirements for the Traction Power System
41. Section 34 21 05 Prefabricated AC and DC Equipment Houses
42. Section 34 21 50 Common Materials and Methods for Traction Power
43. Section 34 21 60 Grounding and Bonding for Traction Power Facilities
44. Section 34 21 80 Traction Power System Field Acceptance Testing
45. Section 34 22 23 Traction Power Cables

**1.03 MEASUREMENT AND PAYMENT**

- A. Separate measurement and payment shall not be made for work required under this Contract Specifications Section. All costs connected with the work specified herein shall be included with the related item of work in the Bid Schedule of the Bid Form, or incidental to the Work.

**1.04 REFERENCES**

- A. All installation activities shall be in accordance with the latest edition of the following codes, standards, and specifications except as provided otherwise herein. Where requirements conflict with requirements specified herein or elsewhere in the Contract, the more restrictive requirements shall apply.

- B. American National Standard Institute (ANSI)

- 1. ANSI/IEEE C2 National Electrical Safety Code

- C. California Building Electrical Code (CBC)

- D. California Code of Regulations (CCR)

- Title 8 Industrial Relations, Division 1, Chapter 4, Subchapter 4, Construction Safety Orders.

- Title 8 Industrial Relations, Division 1, Chapter 4, Subchapter 5, Electrical Safety Orders.

- Title 19 Public Safety, State Fire Marshal.

- Title 24 Part 3, California Electrical Code

- E. CalOSHA – Electrical Safety Orders

- F. Electronics Industry Association (EIA) 568-B Commercial Building Telecommunications Cabling Standard

- G. International Electrical Testing Association (NETA)

- NETA ATS Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

- H. National Fire Protection Agency (NFPA):

- NFPA 70 National Electrical Code

- NFPA 70B Recommended Practice for Electric Equipment Maintenance

- NFPA 70E Standard for Electrical Safety in the Workplace

- NFPA 101 Life Safety Code
- NFPA 110 Emergency and Standby Power Systems
- ANSI/NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems
- NFPA 780 Installation of Lightning Protection Systems

I. National Fire Protection Agency (NFPA):

- 1. NFPA 70 National Electrical Code
- 2. NFPA 70B Recommended Practice for Electric Equipment Maintenance
- 3. NFPA 70E Standard for Electrical Safety in the Workplace
- 4. NFPA 101 Life Safety Code
- 5. NFPA 110 Emergency and Standby Power Systems
- 6. ANSI/NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems
- 7. NFPA 780 Installation of Lightning Protection Systems

J. Telecommunications / Electronics Industry Association (TIA / EIA) 606-A, Administration Standard for Commercial Telecommunications Infrastructure

K. Underwriters Laboratories Inc. (UL)

- 1. UL 486A-486B Standard for Safety Wire Connectors

**1.05 SUBMITTALS**

A. Refer to the following Sections for additional requirements:

- 1. Section 01 33 00, Submittal Procedures
- 2. Section 01 33 23, Shop Drawings, Product Data and Samples

B. Submit following documents for equipment and materials specified herein and provided under the Contract for the traction power facilities:

- 1. Type Test Certificates (Cables).
- 2. Material safety data sheets.
- 3. Product data sheets.

4. Procedures and methods for shipping, handling, unloading, and storage.
5. Installation manual & drawings:
  - a. Installation manual shall include the following:
    - 1) A table of contents that shall identify all pages of the manual by revision and date.
    - 2) A list of all the applicable sections of electrical codes, and of National and Industry Standards applicable to the installation.
    - 3) All the installation practices and procedures that the Contractor plans to use to accomplish the installation of the traction power system. This shall be kept current at all times.
    - 4) A list of all installation drawings by number, revision, title and approval status and a copy of each drawing reduced to B size (11 by 17 inches).
    - 5) All District-approved typical and standard drawings reduced to B size (11 by 17 inches).
    - 6) All quality control procedures associated with the construction of the traction power facilities.
    - 7) All installation verification procedures and data sheets.
    - 8) Staging and implementation plans.
  - b. Installation drawings shall include the following:
    - 1) Mounting details.
    - 2) List of items to be installed.
    - 3) Locating dimensions and associated tolerances.
    - 4) Detailed bill-of-materials.
    - 5) Special installation or process requirements.
6. Rigging Plan
  - a. Rigging plan shall include the following:
    - 1) Plan view showing locations of cranes, operating radii, with delivery or disposal locations shown.
    - 2) Crane rating sheets showing cranes to be adequate for the lift. Crane and boom nomenclature is to be indicated.
    - 3) Plans and computations showing weight of pick.
    - 4) Location plan showing obstructions, indicating that the proposed swing is possible. Location plan shall also show locations of manholes, underground duct banks and other utilities and infrastructure that could be damaged by crane and support vehicle positioning (vehicle body, wheels, and outriggers). Show location and

- type of cribbing and other materials proposed to prevent damage to this infrastructure.
- 5) Data sheet listing type and size of slings or other connecting equipment. Include copies of catalog or information sheets of specialized equipment. Detail method of attachment on erection plan.
  - 6) A complete procedure is to be included, indicating the order of lifts and any repositioning or re-hitching of the crane or cranes.
  - 7) Temporary support of any components or intermediate stages is to be shown.
  - 8) A time schedule of the various stages must be shown, as well as a schedule for the entire lifting procedure.
7. Survey verification records for AC and DC equipment houses and equipment pad foundation installation tolerances.
  8. Product data for outdoor lighting for the traction power facilities.
  9. Product data for the Intrusion detection and surveillance system at traction power facilities.
  10. Cable pull calculations for cables running between AC and DC equipment houses, and between AC and DC equipment houses and points external to traction power facility sites. Calculation shall demonstrate that pull tensions and sidewall pressures are within acceptable tolerances. No cable pulls shall be undertaken prior to acceptance of cable pulling tensions by the District.
  11. Building and equipment anchoring calculations showing anchoring meets seismic requirements. A California professional structural engineer shall approve calculations. Seismic design calculations used shall meet seismic design requirements of the latest California Building Code (CBC) requirements and shall use an Importance Factor (Ip) = 1.5.
  12. Weekly issue tracking logs shall be submitted as part of the progress report to the Engineer.

## **1.06 QUALITY ASSURANCE AND SUPPLIER QUALIFICATIONS**

- A. Refer to Section 01 43 00, Quality Assurance, and Section 01 45 00, Quality Control, for quality assurance, quality control and qualification requirements.
- B. Electrical components, devices, and accessories shall be listed and labeled in conformance with NFPA 70, Article 100. Electrical components, devices, and accessories shall comply with NECA 1, Standard for Good Workmanship in Electrical Construction.
- C. Contract drawings shall indicate preliminary dimensions for equipment, including clearances between equipment and for adjacent surfaces and other items. Deviations to indicated or noted dimensions shall be submitted to the District for review and approval.

- D. The manufacturer of the equipment and cables shall have a minimum of 5 years of successful and proven transit, industrial, or utility experience of providing equipment and cables similar to those furnished under the Contract.
- E. Equipment, devices, components, cabling, materials, and appurtenances shall be proven standard products, or equivalent to the standard products of manufacturers engaged in the production of such entities for at least the past 5 years.
- F. All equipment, devices, components, cabling, materials, and appurtenances shall be new, unused in any other application, and shall possess properties and characteristics in accordance with the applicable industry standards.
- G. All equipment, including parts and devices, shall be new, the manufacturer's latest standard designs that conform to the Contract, and free from defects in material and workmanship.
- H. The construction of all equipment, devices, components, cabling, materials, and appurtenances shall comply, as applicable to the requirements specified in NFPA 130.
- I. Installation Activities
  - 1. All installation activities associated with the traction power facilities shall be performed by a State of California licensed Contractor in accordance with state law. The Contractor shall be skilled and experienced in the installation of the products specified in the Contract.
  - 2. Unlicensed, unskilled, and inexperienced workers shall not be permitted to install equipment, devices, components, cabling, materials, and appurtenances in the field, or perform work of any kind on the Contract.
- J. The Contractor and Contractor's subcontractor(s) shall show evidence of the following to be considered Bidder:
  - 1. Three (3) years minimum experience and three successful projects installing, testing, and commissioning 34.5 kV medium voltage power equipment requiring busway and circuit breakers during the past seven (7) years.
  - 2. Three (3) years minimum experience and three successful projects installing, testing, and commissioning 34.5 kV medium voltage power cables during the past seven (7) years. Experience shall include installation of elbow connectors and outdoor cable terminations.
  - 3. Three (3) years minimum experience and three successful projects installing Class A super-flat concrete surfaces during the past seven (7) years.
  - 4. Evidence of the above experience shall include references with current email addresses and current telephone numbers for each project cited as evidence of experience.

**1.07 DELIVERY, STORAGE AND HANDLING**

- A. Refer to Section 01 60 00, Product Requirements, for general delivery, storage, and handling requirements.
- B. Securely wrap, package, and label each unit for safe handling during shipment. Suitable crating, blocking, and supports shall be provided so equipment and materials will withstand expected domestic shipping and handling shocks and vibration. Clearly label temporary internal bracing of equipment as "Temporary Bracing: To Be Removed Before Operations".
- C. Provide to the District as an option to the base scope of work a secure storage facility (of at least 100,000 square feet) located within 10 miles of the jobsite for a period not least than 1 year to house equipment, pre-engineered houses and cables.
- D. All equipment, cabling, conduit and cable tray, ductbanks, materials, and appurtenances shall be protected and maintained in new condition throughout the Contract period until final acceptance by the District.
- E. All equipment, cabling, conduit and cable tray, materials, and appurtenances intended for use on the Contract shall be shipped and stored in accordance with the manufacturer's recommendations such that damage, distortion or reduction in life is prevented.
- F. All stored equipment, conduit and cable tray, materials, and appurtenances subject to corrosion shall be protected by weatherproof covers or coatings, and off the floor or ground.
- G. Insulated cable ends shall be sealed and stored in a dry location to prevent the entry of moisture into the cable conductors.
- H. All equipment shall be stored with all ports, covers, and all other enclosure openings closed to prevent ingestion of dirt or moisture, and kept dry and free from condensation.
- I. All loose shipped traction power facility components shall include parts and assembly instructions within each package for the components therein.
- J. Special care shall be taken with the storage of electrical equipment prior to installation.
- K. All materials with a defined life expectancy shall be clearly marked with expiration date and shall not be used beyond the expiration date.
- L. All electrical equipment, cabling, conduit and cable tray, materials, and appurtenances with special handling or storage requirements shall be handled or stored according to the manufacturer's requirements.
- M. All equipment, cabling, conduit and cable tray, materials, and appurtenances shall be clearly marked and stored with appropriate nomenclature to prevent misapplication.

- N. Concealed damage shall be inspected and reported to carrier within their required time period.
- O. Rejected or unused equipment, cabling, conduit and cable tray, materials, and appurtenances, or entities, which are not in conformance with the Contract requirements, shall be so marked and promptly removed from the Jobsite.

**1.08 GENERAL REQUIREMENTS FOR THE TRACTION POWER SYSTEM**

- A. Refer to Section 34 21 01, General Requirements for the Traction Power System, for requirements.

**PART 2 – PRODUCTS**

**2.01 UNDERGROUND DUCTBANKS**

- A. Refer to Section 20 50 16, Underground Ductwork and Structures for Facility Services, for the product requirements relating to reinforcement steel, conduits, spacers, ductbank tie-downs, sand, cast-in-place concrete, yellow warning tape, conduit mandrels and brushes, and pull lines.

**2.02 PRECAST STRUCTURES & COVERS**

- A. Refer to Section 20 50 16, Underground Ductwork and Structures for Facility Services, and Section 33 05 16, Utility Structures, for the product requirements relating to pre-cast concrete electrical boxes, pullboxes, ground rod boxes, manholes, handholes, and vaults; covers and frames; gratings; ladders; sumps, inserts; damp proofing, and hardware.

**2.03 CAST IN PLACE STRUCTURES**

- A. Refer to Section 03 05 15, Portland Cement Concrete, Section 03 11 00, Concrete Forming, Section 03 20 00, Concrete Reinforcing, and Section 03 30 00, Cast-In-Place Concrete, for the product requirements relating to Portland cement concrete, concrete forming, and reinforcement steel.

**2.04 CABLE TRENCH COVERS & GRATINGS**

- A. Refer to Section 05 50 00, Metal Fabrications, and Section 33 05 16, Utility Structures, for the product requirements relating to cable trench covers, gratings, and associated vehicle loading.

**2.05 GROUNDING AND BONDING**

- A. Refer to Section 34 21 60, Grounding and Bonding for Traction Power Facilities for the product requirements relating to ground well boxes, ground rods, bare and insulated conductors, ground test stations, jumpers, termination hardware / connectors, exothermic welds, and coatings.

## **2.06 STORM WATER, SEWAGE AND WATER LINES**

- A. Refer to the following Sections for product data:
1. Storm Drainage (Mechanical): Section 22 14 01, Storm Drainage
  2. Storm Drainage (Civil): Section 33 40 00, Storm Drainage Utilities.
  3. Sanitary Sewerage (Mechanical): Section 22 13 01, Sanitary Sewerage.
  4. Sanitary Sewerage (Civil): Section 33 31 00, Sanitary Utility Sewerage Piping.
  5. Water Distribution (Mechanical): Section 22 11 01, Water Distribution.
  6. Water Distribution (Civil): Section 33 11 00, Water Utility Distribution Piping.

## **2.07 SITE FINISH**

- A. Refer to the Contract drawings and applicable sections for requirements.

## **2.08 PERIMETER SECURITY BARRIER**

- A. Refer to Section 03 30 00, Cast-In-Place Concrete, Section 04 22 00, Concrete Unit Masonry, and Section 32 31 13, Chain Link Fences and Gates, for the product requirements relating to concrete masonry units, cement, reinforcement steel, precast beams, lintels and copings, mortar, grout, surface sealant, fence fabric, pipe framework, tension wire, post caps and fittings, truss rods, stretcher bars, accessories, barbed wire extension arms, gates, and pipe sleeves.

## **2.09 GATES**

- A. Refer to Section 05 50 00, Metal Fabrications, and Section 32 31 13, Chain Link Fences and Gates, for the product requirements relating to steel materials, anchors, accessories, galvanization, gate frames, fabrication, and hardware.

## **2.10 EXTERIOR LIGHT FIXTURES**

- A. Refer to Section 26 50 00, Lighting, for the product requirements relating to light fixtures, fixture mounting hardware, and lighting control equipment (as applicable).

## **2.11 BLUE LIGHT STATIONS**

- A. Refer to Section 26 50 00, Lighting, for the product requirements relating to blue light stations.

## **2.12 COMMUNICATIONS EQUIPMENT**

- A. Refer to Section 28 10 01, Access Control Systems, and Section 28 41 29, Closed Circuit Television System, for installation requirements relating to smart card readers and covers; request to exit detectors; key-in-lever cylindrical locksets; energy transfer hinges; door contacts; access control panels; fixed and PTZ cameras; camera housings; camera mountings, and PTZ camera power supply panels. Refer to Section 33 83 01, Radio Network/Trunked Radio System for requirements related to installation of radio systems within traction power facilities.

**2.13 SUMP PUMPS AND ASSOCIATED CONTROLLERS**

- A. Refer to Section 22 14 29, Sump Pumps, for the product requirements relating to sump pumps, motors, controls, guide rails and lifting cables, and hoists.

**2.14 FAILSAFE TO CLOSE DRAIN VALVE WITH OIL DETECTION MATERIALS**

- A. A failsafe shall be provided to close drain valve consisting of, the following:
  1. Filter cage and filters.
  2. Ball valve.
  3. Pipe and fittings.
  4. Mounting hardware and appurtenances.

- B. SPI, Inc. or equal

**2.15 WIRING DEVICES**

- A. Refer to Section 20 70 26, Common Materials and Methods for Electrical Systems, and Section 34 21 50, Common Materials and Methods for Traction Power, for the product requirements relating to toggle switches, commercial grade occupancy sensors, convenience-outlet receptacles, GFCI receptacles, and cover plates.

**2.16 STATIC SIGNAGE**

- A. Refer to Contract Drawings and Sections for product requirements and detailing.

**2.17 CONDUIT, CABLE TRAY AND BOXES**

- A. Refer to Section 20 50 13, Raceways for Facility Services, Section 26 05 29, Hangers, Supports and Seismic Protection, Section 26 05 53, Identification Requirements and Section 34 21 50, Common Materials and Methods for Traction Power, for the product requirements relating to enclosures and boxes; conduit and fittings; conduit mandrels and brushes; cable tray and fittings; mounting hardware, inserts and seismic bracing; coating and compounds; and pull cords.
- B. Cable trays shall be sized (within cable trenches) to permit MV cables to be installed in single layer.

- C. Boxes for fiber optic cables shall be sized to accommodate the fiber optic cable manufacturer's requirements and the NEC/CEC.

**2.18 CABLES AND WIRES**

- A. Unless otherwise specified cables shall:
  1. Be low smoke, zero halogen properties that shall not support combustion.
  2. Pass the flame propagating criteria of IEEE 383 and shall have a minimum circuit time of 5 minutes in the flame test of IEEE 383. Provide test certificate with every shipment of cables.
  3. Comply with requirements specified in NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems.
- B. Refer to Section 26 05 24, Low Voltage Wires and Cables, and Section 34 21 50, Common Materials and Methods for Traction Power, for the product requirements relating to wire and cable markings and color coding, fixture wires, bare conductors, 50 V control circuit wires, cable supports and fasteners, and conductor bundling straps.
- C. Multiple Conductor LV Power, LV Control and Indication Cables shall meet the following criteria:
  1. Conductor Material: ICEA stranded copper meeting requirements of ASTM B3, soft drawn.
  2. Conform to NEMA WC70, approved for use in cable tray
  3. Insulation Rating of 600 V
  4. Multi-conductor cables shall be made by assembling individual or twisted pairs of insulated conductors into a tight cylindrical form using fillers that are compatible with other materials in the cable. The jacket used shall fit tightly to form a firm assembly.
  5. Overall Covering: Cables shall be jacketed over the insulation.
  6. Markings and color coding: Refer to Section 26 05 24, Low Voltage Wires and Cables.
  7. Provide multiple conductor cable for all power applications, except receptacles when installed in cable tray for sizes up to 4/0 AWG.
  8. Control and indication wires shall be minimum of 14 AWG stranded copper.
  9. Size 14 AWG and Larger: NFPA 70, cross-linked-thermosetting-polyethylene insulated in accordance with NEMA WC 70.

- D. Refer to Section 27 13 01, Communication Cables and Related Equipment, for the product requirements relating to fiber optic cables, fiber optic connectors and patch cords, category 6 cables and pigtail cables, emergency trip system cables, hardware, and connections.
- E. Refer to Section 34 22 23, Traction Power Cables, for the product requirements relating to 35 kV and 2400 V cables.

**2.19 CABLE SPLICE AND TERMINATION HARDWARE**

- A. Refer to Section 34 21 50, Common Materials and Methods for Traction Power, for the product requirements relating to LV cable splice and terminal connectors; and associated insulated materials.
- B. Refer to Section 34 22 23, Traction Power Cables, for the product requirements relating to MV cable in-line, continuous splice kits, insulated splice kits, lugs, and fireproofing materials.

**2.20 34.5 KV JUNCTION CUBICLES**

- A. Refer to Section 34 21 50, Common Materials and Methods for Traction Power for the product requirements relating to the cubicle design, construction, and components.

**2.21 34.5 KV ISOLATION DISCONNECT SWITCHES**

- A. Refer to Section 34 21 56, 34.5 kV Isolation Disconnect Switches, for the product requirements relating to the isolation disconnect switches design, construction, and components.

**2.22 MANUAL 1,500V DC DISCONNECT SWITCHES**

- A. Refer to Section 34 21 55, for the product requirements relating to enclosure, switch blade and contact surfaces, auxiliary contacts, cable terminations and connections, cable supports, gasketing, and nameplates.

**2.23 IDENTIFIERS**

- A. Refer to Section 26 05 53, Identification Requirements for the identifier product requirements for component tags, equipment nameplates, conduit and cable trays, underground ductbanks, outlets, junction and pull boxes, wires cables, and fiber optic strands.

**2.24 VOLTAGE MARKERS AND SAFETY SIGNAGE**

- A. Refer to Section 26 05 53, Identification Requirements, for the product requirements for voltage markers, warning labels, shock hazard and arc flash labels, safety, and instructional signs.

**2.25 FIRE PROOFING/BARRIERS**

- A. Refer to Section 07 84 00, Firestopping, for the product requirements relating to fire stopping sealant, foam, and mineral fiber.

**PART 3 – EXECUTION**

**3.01 GENERAL**

- A. Overview
  1. Furnish and install the traction power facilities' civil infrastructure including earthwork, grading, foundations, pavement, landscaping, fencing, perimeter lighting as indicated.
  2. Furnish and install equipment, conduit, underground ductbanks and structures, cable trays, cables in accordance with the National Electrical Installation Standards (NEIS) of the National Electrical Contractors Association (NECA).
  3. Perform all electrical work in accordance with electrical work stages, phases and step schedule developed by the Contractor and approved by the District.
  4. Perform and complete all work in a thorough, workmanlike manner, and shall follow the best modern practice in the installation of high-quality equipment and materials, notwithstanding omission of any requirement from the Contract.
  5. Make and install all parts accurately to American standard gauges for ease of replacement and repairs. The Contractor shall furnish all special gauges and templates necessary for field erection. These shall become the property of the District at no extra cost.
  6. Technical representative(s) from the traction power equipment supplier's organization shall be made available for supervision during installation of their equipment.
  7. The information and requirements specified within the Contract do not make representations regarding the character or extent of the subsoils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions based on examination of the Jobsite or other information. Failure to examine the Contract or other information does not relieve the Contractor of responsibility for the satisfactory completion of the work.
  8. Fees and Permits
    - a. In accordance with General Conditions Article GC7.4 (and associated Special Conditions), Contractor shall pay all required fees and obtain all

required permits related to the work specified herein and elsewhere in the Contract.

- b. Royalties or fees in connection with the use of patented devices and systems shall be paid at no additional cost to the District.
- c. Controlled inspection shall be provided where required by authorities having jurisdiction and by the Contract.

B. Installation Requirements

- 1. Install electrical materials, equipment, and accessories in locations as required, rigid and secure, plumb and level, and in alignment with related and adjoining work.
- 2. When installing conduits, supports, or structural members on existing concrete surfaces, x-ray scanning shall be used to determine location of embedded structural members. Installation of new equipment shall not impact structural integrity of existing structures in any way.
- 3. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts, angles and anchoring as required to meet the seismic design requirements as specified herein and elsewhere in the Contract. Electrical materials shall not be welded for attachment or support.
- 4. Erection tolerance requirements shall not impair the strength, safety, serviceability, or appearance of the installations.
- 5. Contractor shall coordinate the Work with the Engineer in accordance with the following:
  - a. The Contract establishes overall installation scope, materials and quality but not all details or complete installation instructions. Contract drawings are diagrammatic.
  - b. The Contract shows the general arrangement of equipment and appurtenances. Follow the Contract as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories, which may be required but not shown on the Contract. Investigate the Jobsite, and review drawings of other trades to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.
  - c. The locations of infrastructure indicated on the Contract are subject to such revision as may be found necessary or desirable at the time the work is installed, or to meet field conditions, or to simplify the work, or for other legitimate causes. Exercise caution regarding the location of items. Provide precise and definite locations to the Engineer and have it accepted by the Engineer before proceeding with the installation.
  - d. The Contract shows estimated runs of raceways and locations of equipment. Any significant changes in location of equipment necessary to meet field conditions shall be brought to the immediate attention of the

Engineer for review and approval before such alterations are made. Modifications shall be made at no additional cost to the District.

- e. Circuit tags in the form of numbers are used where shown to indicate the circuit designation numbers. Show the actual circuit numbers on the as-built record drawings and on the associated typed equipment enclosure directory card.
  - f. The Contract generally does not indicate the number of wires in conduit for the feeder and branch circuit wiring, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and circuit numbers indicated, the control intent, referenced wiring diagrams, the specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC and CEC.
  - g. Furnish and set sleeves for passage of electrical risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each electrical riser passing through building surfaces.
  - h. Provide firestopping around all items including pipes, conduits ducts, and sleeves which pass through rated walls, partitions, and floors.
  - i. Provide required supports and hangers for conduit and equipment, designed so as not to exceed allowable loadings of structures.
  - j. Adjust location of items including to accommodate the work to prevent interferences, both anticipated and encountered.
  - k. Right-of-Way: Lines which slope have the right-of-way over those which do not slope. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
  - l. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
6. Cutting and Patching shall be performed in accordance with the following:
- a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, and metalwork using skilled people of the trades required at no additional cost to the District.
  - b. Do not cut, channel, chase or drill unfinished masonry, tile, etc., unless permission from the Engineer is obtained. If permission is granted, perform this work in a manner acceptable to the Engineer.
  - c. Provide slots, chases, openings, and recesses through floors, walls, ceilings, and roofs as required.
  - d. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no cost to the District.
7. Equipment and material shall be protected in accordance with the following:

- a. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damage caused without additional cost to the District.
  - b. Take responsibility for work, materials, and equipment until finally inspected, tested, and accepted.
  - c. Protect work against theft, injury, or damage, and carefully store material and equipment received on the Jobsite, which is not immediately installed.
  - d. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material.
  - e. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc.
  - f. Store equipment subject to moisture damage in dry, heated spaces.
  - g. Provide adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance.
  - h. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry.
  - i. Do not install damaged items. Take immediate steps to obtain a replacement item or repair the damaged item.
8. Mounting Heights
- a. Unless otherwise specified on the Contract drawings and other sections equipment enclosures, install light fixtures, wiring devices, and static signage in accordance with the approved construction design deliverables and as specified herein:
    - 1) Centerline of receptacles: 18 inches above finished grade.
    - 2) Centerline of light switches and static signage: 48 inches above finished grade.
    - 3) Top of equipment enclosures (wall and pedestal mounted) shall not exceed 6 feet, 6 inches above finished grade. Bottom of equipment enclosures (wall and pedestal mounted) shall be at least three feet above finished grade.
    - 4) Blue light station's light fixture shall not exceed 6 feet 6 inches above finished grade.
9. After installations are complete, surfaces shall be thoroughly cleaned. Where shop paint coating is missing or abraded bare steel is exposed, including bolts, nuts, washers, and welds, paint each item with the same paint system as used for shop painting. Provide touch-up painting by approved spray methods or brush where spray-painting is not practical.

- C. Modifications to existing traction power facilities shall be in accordance with the following:
1. Refer to Section 01 35 14, Operating System Interface, for additional requirements relating to working on and adjacent to the operating system.
  2. Survey the traction power facility, ancillary spaces and associated equipment, and underground structures. Verify the existing configuration (without interrupting or interfering with revenue service operations) and use it as a base for all modifications.
  3. Coordinate and schedule Installation activities to ensure the District's revenue service operations are not disrupted during the performance of the work
  4. Submit staging and implementation plans for the Work, including interface to existing operating System, testing and cut-over of both completed systems.
  5. Provide the District with resource requirements to be supplied by the District (e.g. safety monitor support, safe clearances).
  6. Implement an approved safety system prior to and during the execution of the Work.
  7. Conduct pre-activity meetings with applicable stakeholders within the District and third-party utility service provider(s).
  8. Install equipment, conduits, cable tray, cables, materials and appurtenances in accordance with the approved construction design deliverables to provide a complete and operable system.
  9. Unless otherwise specified in the Contract, conduit extensions to existing operational installations shall match existing conduit sizes.
  10. Reconfiguration and temporary disconnection of third party utilities shall be coordinated with the respective third party utility service provider(s).
  11. Protect existing infrastructure in place during the execution of the Work.
  12. Clearly delineate "new" Work from existing operational circuits. Provide signage communicating contact person(s), cellphone number(s) and restrictions.
  13. Remove, replace, and salvage (as applicable) existing equipment, conduits, cable tray, cables, materials and appurtenances as indicated in the Contract.
  14. Transport removed items off the District's right of way and dispose of items in accordance with Federal, State and local ordinances.
  15. Coordinate firmware and software interfaces and changes with the District.

- 16. Restrain and electrically isolate un-terminated new conductors and associated termination hardware to prevent accidental contact with existing operation circuits.
  - 17. The Contractor shall not terminate new conductors and fiber optic strands to existing operational circuits.
  - 18. If construction activities impact revenue service operations and functionally impair or damage existing operational circuits, cease Work immediately and follow the direction of the Engineer.
- D. Replace damaged Work prior to final acceptance at no additional cost to the District.
  - E. Refer to Section 34 21 01, General Requirements for the Traction Power System, and Contract drawings for additional requirements.
  - F. Review equipment vendor designs against the Contract drawings. Notify the Engineer of discrepancies and seek direction.

**3.02 THIRD PARTY UTILITIES (TEMPORARY AND PERMANENT)**

- A. Refer to Section 01 11 00, Summary of Work, and Section 34 21 01, General Requirements for the Traction Power System, for additional requirements.
- B. Submit permit applications with applicable design documentation to third party utility service providers and obtain approval prior to the commencement of construction activities.
- C. Call Underground Service Alert or equivalent and affected utility companies two (2) Working Days (not including initial day of contact) in advance before digging, grading or excavating for the marking of underground member utilities.
- D. Unless otherwise specified by the third-party utility service provider, comply with the following requirements:
  - 1. Excavation, bedding, and backfill shall be in accordance with Section 33 05 28, Trenching and Backfilling for Utilities.
  - 2. Clean excavation prior to placement of third party utility infrastructure.
  - 3. Dewater all excavations in accordance with Section 31 23 19, Dewatering.
  - 4. Provide a compacted aggregate base under underground structures in accordance with Section 32 11 24, Aggregate Drainage Layer, and Section 33 46 00, Subdrainage.
- E. Field verify locations for existing utilities and suitability prior to beginning installation of the third-party utility infrastructure. Check with USA survey or other third party survey company to verify existing underground facilities prior to excavation. Discovery of conflicts with existing utilities and/or unsuitable conditions shall be immediately brought to the attention of the Engineer for review and direction.

- F. Construct 3rd Third party utilities in accordance with the approved design, CPUC General Orders, third party utility service provider's construction requirements and the requirements specified herein or elsewhere in the Contract.
- G. Provide appropriate safety barriers, ventilation and gas monitoring devices in accordance with CalOSHA requirements.
- H. Schedule and undertake inspections of third party utility infrastructure with the respective third party utility representative(s) and the Engineer prior to backfilling and installation of concrete and equipment. Ensure applicable field tests have been completed and test records are available prior to inspections. Corrective work requiring approval shall be performed at no additional cost to the District.
- I. Provide documentation to formalize acceptance (inspection and testing) by the third party utility service providers of the as-built utilities provided under the Contract.

**3.03 EQUIPMENT PLACEMENT (AC AND DC EQUIPMENT HOUSES, TRANSFORMERS)**

- A. Refer to Specification Section 34 21 05 Article 3.05 and manufacturers' recommendations for requirements.

**3.04 UNDERGROUND DUCTBANKS AND STRUCTURES**

- A. General
  - 1. Comply with requirements specified in Art. 3.02 C to E inclusive and G above.
  - 2. Install temporary covers to secure underground structures and associated field installed cables, and to prevent accidents.
  - 3. Provide engraved contract number designations on each cable trench or vault cover (to cable trenches).
  - 4. Schedule and undertake inspections of underground ductbanks and structures with the Engineer prior to backfilling and/or installation of concrete / equipment. Ensure applicable field tests have been completed and test records are available prior to inspections. Corrective work requiring approval shall be performed at no additional cost to the District.
  - 5. Remove all construction material and debris from underground/precast structures, sump pump structures, cable trenches and ground wells prior to pre-final punchlist inspections, energization of LV and MV conductors, and/or operating optical networks.
  - 6. Install permanent covers prior to pre-final punchlist inspections, energization of LV and MV conductors, and/or operating optical networks.

7. Provide permanent ladders on walls of all underground structures more than 36 inches deep (to cable trenches).
- B. Underground Ductbanks
1. Underground ductbanks shall be installed in accordance with Section 20 50 16, Underground Ductwork and Structures for Facility Services.
  2. Routing of electric utility underground ductbanks within the traction power facilities shall be minimized.
  3. Mandrel and clean all conduits prior to cable/wire installation.
- C. Precast Structures
1. Precast structures shall be installed in accordance with Section 33 05 16, Utility Structures.
- D. Cable Trenches
1. Cast in place cable trenches shall be installed in accordance with Section 03 11 00, Concrete Forming, Section 03 05 15, Portland Cement Concrete, Section 03 20 00, Concrete Reinforcing, and Section 03 30 00, Cast-In-Place Concrete.
- E. Sump Pump Structures
1. Cast in place sump pump structures shall be installed in accordance with Section 03 11 00, Concrete Forming, Section 03 05 15, Portland Cement Concrete, Section 03 20 00, Concrete Reinforcing, and Section 03 30 00, Cast-In-Place Concrete.
  2. Sump pump precast structures shall be installed in accordance with Section 33 05 16, Utility Structures. Sump pump structures shall be separate from cable trenches.
- F. Covers
1. Provide covers with embossed or engraved identification as indicated on the Contract Drawings and as specified in Section 33 05 16, Utility Structures.
  2. Covers of underground/precast structures, sump pump structures, cable trenches and ground wells shall be installed flush with the finished grade.
  3. Install security hardware on all covers within the traction power facility sites, along the alignment and in areas that are accessible by the public.
  4. Covers for underground structures, that are accessible by the public and/or roadway vehicles (operated by non-BART entities), shall not protrude above finished grade when the security hardware is not properly installed and loose (i.e. have no spring assist features).

**3.05 GROUNDING AND BONDING**

- A. Except for high-resistance grounded equipment, all other current carrying non-conductive entities (e.g. gates, handrails, gratings, electrical equipment enclosures, support structures, metallic raceways, metallic conduits, metallic cable trays, covers for underground structures and trenches, boxes, cabinets, exposed expansion joints, site lighting fixtures and mounting poles, and receptacles) shall be grounded as required by NEC, CEC, and as indicated on the Contract drawings.
- B. Equipment grounding conductors shall be connected to the ground test stations within the AC or DC equipment houses, uniquely identified (correlating with the equipment they originate from) and shall be insulated from high-resistance grounded equipment.
- C. Grounding and bonding of third party utility services shall be installed in accordance with the requirements of the respective third party utility service provider(s).
- D. Grounding and bonding shall be installed and tested in accordance with Section 34 21 60, Grounding and Bonding for Traction Power Facilities.

**3.06 EQUIPMENT/STRUCTURE / LIGHT FIXTURE POLE FOUNDATIONS, CONTAINMENT STRUCTURES AND STAIRWAYS**

- A. Third party electric utility equipment foundations, containment structures, equipment pads, shall be installed in accordance with the requirements of the third party electric utility service provider(s).
- B. Cast in place equipment, structure and light fixture pole foundations, containment structures, and stairways shall be installed in accordance with Section 03 11 00, Concrete Forming, Section 03 05 15, Portland Cement Concrete, Section 03 20 00, Concrete Reinforcing, and Section 03 30 00, Cast-In-Place Concrete.
- C. Support reinforcing steel with concrete blocks. Tie the reinforcing steel with steel wire to maintain spacing and clearances shown on the Contract drawings.
- D. Unless otherwise specified do not weld reinforcing steel at laps or intersections.
- E. Prior to pouring concrete use templates to accurately locate anchor bolts and leveling channels in accordance with the Contract drawings. Ensure no movement during the concrete pour and vibration.
- F. Unless otherwise specified do not weld or bend anchor bolts and levelling channels.
- G. Conduct the following concrete tests at each traction power facility site:
  - 1. Slump test.
  - 2. Air content test.
  - 3. Strength test.

- H. Apart from light fixture pole foundations and stairways, the footprint of equipment and house foundations shall extend not less than 4 inches larger in both directions beyond the actual equipment and house footprint.
- I. The walls of containment areas shall extend not less than 4 inches larger in both directions beyond the actual equipment footprint for each oil filled transformer (inclusive of fins and valves).
- J. Install the failsafe to close drain valve with oil detection in accordance with the Contract drawings and the manufacturer's recommendations.
- K. The entrance landing to the AC and DC equipment houses, that has been designated for circuit breaker removal shall be sized and constructed to permit circuit breaker placement on it with door opened only 90 degrees.
- L. Install embedments for gratings in equipment foundations and containment walls.
- M. Install leveling channels in the foundations associated with the AC and DC equipment houses, rectifier transformers, auxiliary power transformers, 34.5 kV isolation disconnect switches and 34.5 kV junction cubicles.
- N. Install the bottom of the containment wall's outlet at least 1 inch above finished grade exterior to the containment and account for accessibility to the outlet valve.
- O. Install outlet valve(s) at each containment structure.
- P. Coordinate offsets and stub-up locations of ground pigtails, conduits, sleeves, water supply and drainage pipes.
- Q. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury
- R. Demolish foundations that allow standing water and install new foundations at no additional cost to the District.
- S. Remove spalling in concrete surfaces.
- T. Install grout at all openings between equipment and concrete surfaces.
- U. Patch holes and/or openings in finished concrete surfaces.
- V. Install yellow reflective striping on stairs and elevated curb thresholds at gates and/or walkways.
- W. Install covers for the underground structures and cable trenches.
- X. Install safety bars in all cable trenches in accordance with the Contract drawings.
- Y. Verify that foundation grades, embedded leveling channels, and anchor bolt locations are correct and shall perform the following:

1. All leveling channels in each foundation shall vary from the horizontal by not more than 1/8 inch over the length of the leveling channel. Foundation leveling channels shall vary by not more than 1/8 inch with reference to other leveling channels over the length of the leveling channels. Where equipment vendor prescribes stricter installation tolerances, the more stringent requirements shall apply.
  2. Level of the top of all foundation concrete shall be a minimum of 1/8 inch below top face of embedded leveling channels.
  3. Top face of house foundation or equipment pad concrete shall vary by not more than 1/8 inch over entire foundation or equipment pad face.
- Z. Submit field survey data confirming foundation adherence to required tolerances for each equipment house and equipment pad.
1. If the survey shows that leveling channels are not level to within required tolerances as specified above, channels shall be made level before setting of the equipment or house. Methods used to level channels shall be approved by the District, and shall meet all seismic requirements suitable for the construction in accordance with the approved seismic design.
  2. If survey shows that the face of the pad or foundation concrete is out of the required tolerance, the high points shall be ground down to within the required tolerance before setting of the equipment or house.
  3. If the survey shows the pad or foundation locations vary by more than plus or minus 1/8 inch, the Contractor shall correct the installation at no additional cost to the District.
  4. AC and DC equipment house and rectifier transformer foundations shall vary by not more than 1/8 inch from locations depicted on the Contract drawings.
  5. Efficacy of methods proposed to correct location, heights of foundation pads, or levels of equipment house leveling channels shall be confirmed by seismic calculations done by a Registered California Professional Structural Engineer, and shall meet all seismic requirements suitable for essential facilities as defined in the CBC and as required by Specification Section 34 21 01.
  6. All calculations shall be submitted to the Engineer for approval.
  7. Following approval of remediation methods and seismic design calculations, the Contractor shall perform all remedial actions necessary to bring foundation pad into construction tolerance.
  8. Delivery and installation of AC and DC equipment houses and traction power transformers may occur only following District approval of foundation pad survey data and any required remediation calculations, remedial work, and re-survey of equipment pad by an independent third party surveyor.

**3.07 SITE PERIMETER SECURITY BARRIER AND GATES**

- A. Perimeter security barrier and gates shall be installed in accordance with Section 03 30 00, Cast-In-Place Concrete Section 04 22 00, Concrete Unit Masonry, Section 05 50 00, Metal Fabrications, and Section 32 31 13, Chain Link Fences and Gates.
- B. Install footings clear of third party utilities, underground ductbanks and structures, and ground grid components.

**3.08 SITE FINISH, PARKING AND ACCESS ROADWAY**

- A. Site Finish
  - 1. Refer to the Contract drawings and applicable Sections for requirements.
  - 2. Grade the site finish material up around the cable trenches and underground structures to ensure a smooth transition between asphalt and surrounding material and effectively prevent water ingress into them.
- B. Parking
  - 1. Refer to the Contract drawings and applicable Contract sections for requirements.
- C. Access Roadway(s)
  - 1. Refer to the Contract drawings and applicable Contract sections for requirements.

**3.09 MISCELLANEOUS EQUIPMENT**

- A. 35 kV Elbow termination enclosure shall be provided in accordance with the following:
  - 1. Install 35 kV elbow termination enclosures at each traction power facility in accordance with Section 34 21 50, Common Materials and Methods for Traction Power and the approved construction design deliverables.
  - 2. Ensure there is at least 8 feet horizontal clearance and a level working platform in front of the 35 kV elbow termination enclosures to permit hot stick operation.
  - 3. Install vehicle barriers adjacent to the 35 kV elbow termination enclosures, where they are located at a point that can be accessed by O&M vehicles.
- B. 35 kV Isolation Disconnect Switches shall be provided in accordance with the following:
  - 1. Install 35 kV isolation disconnect switches at each traction power facility in accordance with Section 34 21 56, 35 kV Isolation Disconnect Switches and the approved construction design deliverables.

2. Ensure there is at least 8 feet horizontal clearance and a level working platform in front of the 35 kV isolation disconnect switches to permit hot stick operation.
3. Install vehicle barriers adjacent to the 35 kV isolation disconnect switches, where they are located at a point that can be accessed by O&M vehicles.

C. Site Lighting

1. Install site lighting fixtures, poles and mounting hardware shall in accordance with Section 26 50 00, Lighting, and the approved construction design deliverables.

D. Blue Light Stations

1. Install a blue light station within each traction power facility, 6 feet or less from the entrance gate, in accordance with Section 26 50 00, Lighting and the approved construction design deliverables.

E. Communications

1. Install communications equipment in accordance with Division 27, Communications, Section 28 10 01, Access Control Systems, and Section 28 41 29, Closed Circuit Television Systems, and the approved construction design deliverables.

F. Sump Pumps and Associated Equipment

1. Sump pumps, materials and associated equipment shall be installed in accordance with Section 22 14 29, Sump Pumps.
2. Install sump pump controllers at grade within the traction power facilities. Working clearances shall comply to NEC / CEC.

G. Wiring Devices shall be provided in accordance with the following:

1. Install wiring devices in accordance with Section 20 70 26, Common Materials and Methods for Electrical Systems, and Section 34 21 50, Common Materials and Methods for Traction Power.
2. Install switches, receptacles, special purpose outlets, and cover plates completely and neatly in accordance with California Electrical Code (CEC), and Section 20 70 26, Common Materials and Methods for Electrical Systems. Plug or cover unused openings in boxes, cabinets, and equipment.

**3.10 STATIC SIGNAGE**

- A. Refer to Section 34 21 01, General Requirements for the Traction Power System, for requirements.

- B. Refer to Contract drawings for mounting height and horizontal clearance requirements.

**3.11 FIELD INSTALLED CONDUIT, CABLE TRAY AND BOXES**

- A. Install conduits, fittings and mounting hardware in accordance with the approved construction design deliverables, manufacturer's instructions, Section 20 50 13, Raceways for Facility Services, Section 26 05 29, Hangers, Supports and Seismic Protection, Section 26 05 53, Identification Requirements, Section 34 21 50, Common Materials and Methods for Traction Power, and as specified herein elsewhere in the Contract.
- B. Install separate conduits for cables of different systems / applications / utilization voltage categories.
- C. Metallic conduits entering high resistance grounded equipment shall be insulated from the equipment enclosures.
- D. After installation of 34.5kV ac, 1000V dc positive and negative cables in trays, paint or tape the cables with fire-proofing materials.

**3.12 FIELD INSTALLED CONDUCTORS/CABLES AND FIBER OPTIC CABLES**

- A. Furnish the following categories of cables as indicated in the Contract:
  1. 35 kV ac cables and associated terminations, hardware and accessories.
  2. 2.4 kV dc cables for the positive and negative feeders, and associated terminations, hardware and accessories.
  3. 2.4 kV dc cables for dc switchgear load measuring circuits.
  4. Low-voltage cables and wires between ac equipment house, rectifier transformers, dc equipment house, and other outdoor equipment within the traction power facility.
  5. Fiber-optic and other communication cables and associated termination accessories, for interfacing the traction power facility with the District's communication network; or, with other traction power facilities and devices.
- B. Install and terminate cables, conductors and fiber optic strands in accordance with the approved construction design deliverables, cable manufacturer's instructions, Section 26 05 24, Low Voltage Wires and Cables, Section 27 13 01, Communication Cables and Related Equipment, and Section 34 22 23, Traction Power Cables, and as specified herein.
- C. Cables shall be handled in such a manner as to prevent damage to the insulation. The ends of the cable shall be covered to prevent dirt and moisture from entering the cables during handling and installation. The cable shall be kept dry prior to and during installations and shall not be exposed to oil or grease.

- D. Unless permitted by the NEC or CEC, cables of different systems/applications/voltage categories shall be routed in separate conduits. Fiber optic cables shall be routed and protected in accordance with EIA 568-B, TIA 606-A, NECA 301 and Section 27 13 01, Communication Cables and Related Equipment
- E. Cable Pulling
1. Submit cable pulling calculations for cable pulls between equipment houses, between pads, and between traction power facilities and sites external to traction power facilities such as trainways. Calculation shall demonstrate that pull tensions and sidewall pressures are within acceptable tolerances. No cable pulls shall be undertaken prior to acceptance of cable pulling tensions by the District.
  2. Cables shall be pulled directly into the conduits from cable reels. The pulling speed shall be limited so that the cables move smoothly into the conduit at a uniform velocity. Steel pulling lines shall not be used in non-metallic conduit. Where pulling grips are used, damaged ends shall be removed as soon as the cables have been installed.
  3. Wherever two or more conductors are pulled into one conduit, the cables shall be uncoiled from the two or more reels simultaneously.
  4. After installation, all exposed cables and those that are accessible shall be cleaned of dirt, grease, and pulling lubricant, using a commercial cable cleaner approved by the cable manufacturer.
- F. Cables within the traction power facilities shall be continuous without splices.
- G. Fiber Optic Cable Service loops shall be provided in accordance with the following:
1. Install a minimum of 50 feet service loop at both ends of each fiber optic cable run.
  2. Coil up the service loop and secure it to a wall within ancillary spaces.
  3. Coil the service loop (associated with interbuilding cables) and secure it within the underground structure nearest the DC switchgear house.
  4. Five (5) feet service loop, at each end are required for each intrabuilding cable between the AC and DC equipment houses.
- H. Low voltage circuits requiring external connections and all unused terminals on auxiliary contacts, devices, relays, and control switches shall be brought to accessible terminal blocks.

### 3.13 CABLE SPLICES AND TERMINATIONS

- A. LV Cable Splices and Terminations
  - 1. LV Cable splices and terminations shall be installed in accordance with Section 20 70 26, Common Materials and Methods for Electrical Systems, Section 26 05 24, Low Voltage Wires and Cables, and Section 34 21 50, Common Materials and Methods for Traction Power.
- B. MV Cable Splice and Termination
  - 1. MV Cable splice and termination shall be installed in accordance with Section 34 22 23, Traction Power Cables.
- C. Fiber Optic Cable Splice and Termination
  - 1. Fiber optic cable splice and termination shall be installed in accordance with Section 27 13 01, Communication Cables and Related Equipment.
- D. Wire Terminations
  - 1. Connectors and terminals shall have temperature ratings equal to or greater than those for the wiring and shall be in accordance with UL 486A and UL 486B.
  - 2. Connections shall be made only at the terminals on the devices, on terminal blocks, or on the buses:
    - a. No splices or taps shall be made between these terminal points.
    - b. No more than two wires shall be connected to any terminal point.
    - c. Connections shall be made by ring- or spring-type lugs with insulated compression sleeves. The insulated sleeve shall firmly grip the wire insulation, and the metallic portion shall firmly grip the strands of the conductor. The crimping tool and lugs shall be of a system design in which the crimping tool will not release until the crimp has been completed.
  - 3. Low voltage circuits requiring external connections and all unused terminals on auxiliary contacts, devices, relays, and control switches shall be brought to accessible terminal blocks.

### 3.14 IDENTIFICATION

- A. Identifiers shall be installed in accordance with Section 26 05 53, Identification Requirements and the Contract drawings.
- B. Identify all used and spare equipment, 34.5 kV elbow enclosures, 34.5 kV isolation disconnect switches, enclosures, components, conduits, cable trays, underground ductbanks and covers, boxes, cables, termination points, wiring devices, conductors and fiber optic strands.

- C. Identification content shall match the information contained in the approved construction design deliverables.

**3.15 MISCELLANEOUS MATERIALS / APPURTENANCES**

- A. Fire Proofing and barriers shall be installed in accordance with the following:
  - 1. Install fire proofing and barriers at all floor penetrations to the AC and DC equipment houses.
  - 2. Patch or replace missing structural steel fire-proofing on the underside of AC and DC equipment houses. Coordinate with the Engineer whether to patch or replace the missing structural steel fire-proofing.
- B. Rodent & Water Barrier
  - 1. After all field installed cables have been tested and before final punchlist inspections, energization of LV and MV conductors, and operating optical networks, install rodent and water barrier at the following locations:
    - a. Conduit stub-ups at rectifier transformers, 34.5 kV elbow enclosures, 34.5 kV isolation disconnect switches, and handholes.
    - b. Conduit stub-outs at underground structures and cable trenches.

**3.16 RESTROOM FACILITIES**

- A. Refer to the Contract drawings and applicable specifications for requirements.
- B. Install footings clear of third party utilities, underground ductbanks and structures, and ground grid components.

**3.17 SPARES PROVISIONS**

- A. Equipment
  - 1. Refer to individual Sections and the Contract Drawings for the requirements.
- B. Consumables
  - 1. At least two items or 10 percent spares of general consumables (e.g. fuses, indication lights) shall be provided for each traction power facility.
- C. Underground ductbanks and conduits
  - 1. At least one or 10 percent of spare conduits, whichever is greater, shall be provided in each underground ductbank for each different system, application, and utilization voltage categories.

2. At least one or 10 percent of spare conduits, whichever is greater, shall be provided for each different system, application, and utilization voltage categories in each horizontal and vertical conduit runs between equipment enclosures, equipment enclosures and wireways within the AC and DC equipment houses.

D. Conductors and fiber optic strands

1. At least 20 percent spare conductors shall be provided for all multi-conductor control and indication cables.
2. At least 20 percent spare fiber strands shall be provided for all fiber optic cables (associated with the Traction Power System).
3. Terminate spare conductors and fiber optic strands and, ensure they are not electrically/optically connected to operational circuits.

E. Termination blocks/patch panels

1. Provide termination blocks and patch panels (fiber optic, multi-conductor and/or cat 6a) for the installed and future spare capacity (per Article 3.16 D herein) conductors and fiber optic strands.

**3.18 INSPECTION AND TESTING**

- A. Inspect and/or test the AC & DC equipment houses, rectifier transformers, auxiliary transformers, 34.5 kV elbow enclosures, 34.5 kV isolation disconnect switches, LV equipment, underground structures, cable trenches, etc. in accordance with Section 34 21 80, Traction Power System Field Acceptance Testing.
- B. All spare equipment, conductors and fiber strands shall be inspected and tested.

**3.19 CLEANING**

- A. Refer to Section 01 74 14, Cleaning, for additional requirements.
- B. Remove all waste materials from the Jobsite(s) at no additional cost to the District.

**3.20 DEMOBILIZATION**

- A. Refer to Section 01 71 13, Mobilization, for additional requirements.
- B. Remove construction tools, materials and temporary construction utilities from each traction power facility.
- C. Ensure equipment is left in its post field tested condition(s) where the Contractor has accessed equipment enclosures post field testing activities.

- D. In the case of equipment that is electrically and/or optically connected to the operating system the Contractor shall not access the equipment without formal permission from the Engineer. Where permission is granted, schedule equipment access with the Engineer and only access the equipment when the Engineer is present on-site.

**3.21 CLOSEOUT PROCEDURES**

- A. Refer to Section 01 77 00, Closeout Procedures, and Section 01 78 39, Project Record Documents, for the requirements.

**END OF SECTION 34 21 70**