

SECTION 34 21 05

PREFABRICATED AC AND DC EQUIPMENT HOUSES

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Prefabricated AC and DC equipment houses including ancillary equipment.
- B. Factory installation and acceptance testing of the fully equipped AC and DC houses.
- C. Field Installation, verification, functional, and system integration testing of AC and DC houses.

1.02 RELATED SECTIONS

- A. Refer to the following Sections for requirements:
 - 1. Section 01 33 00 Submittal Procedures
 - 2. Section 01 33 23 Shop Drawings, Product Data, and Samples
 - 3. Section 01 43 00 Quality Assurance
 - 4. Section 01 45 00 Quality Control
 - 5. Section 01 45 24 Testing Program Requirements
 - 6. Section 01 74 14 Cleaning
 - 7. Section 01 77 00 Closeout Procedures
 - 8. Section 01 78 23 Operation and Maintenance Data
 - 9. Section 01 78 39 Project Record Documents
 - 10. Section 01 78 44 Spare Parts and Maintenance Materials
 - 11. Section 01 79 00 Demonstration and Training
 - 12. Section 05 05 22 Metal Welding
 - 13. Section 05 12 00 Structural Steel Framing
 - 14. Section 05 40 00 Cold Formed Metal Framing
 - 15. Section 07 81 16 Cementitious Fireproofing
 - 16. Section 07 81 24 Intumescent Fireproofing
 - 17. Section 08 71 00 Door Hardware

PREFABRICATED AC AND DC EQUIPMENT HOUSES

- 18. Section 08 90 00 Louvers
- 19. Section 10 40 00 Safety Specialties
- 20. Section 20 10 13 Common Materials and Methods for Facility Services - Fire Suppression, Plumbing and HVAC
- 21. Section 20 50 13 Raceways for Facility Services
- 22. Section 23 09 00 Instrumentation and Control for HVAC
- 23. Section 23 34 00 HVAC Fans
- 24. Section 23 81 00 Unitary HVAC Equipment
- 25. Section 26 05 17 Dry Type Transformers
- 26. Section 26 05 24 Low Voltage Wires and Cables
- 27. Section 26 24 24 Circuit Breakers and Panelboards
- 28. Section 27 13 01 Communication Cables and Related Equipment
- 29. Section 27 30 01 Telephone Systems
- 30. Section 28 10 01 Access Control Systems
- 31. Section 28 31 00 Fire Detection and Alarm System
- 32. Section 28 41 29 Closed Circuit Television System
- 33. Section 34 21 01 Traction Power Facilities General Requirements
- 34. Section 34 21 18 AC Switchgear
- 35. Section 34 21 25 DC Switchgear
- 36. Section 34 21 28 Auxiliary Power Transformers (Dry Type)
- 37. Section 34 21 33 Control, Monitoring and Display Panel
- 38. Section 34 21 40 DC Control Power System
- 39. Section 34 21 50 Common Materials and Methods for Traction Power
- 40. Section 34 21 60 Grounding and Bonding of Traction Power Distribution
- 41. Section 34 21 70 Traction Power Facilities Installation Requirements
- 42. Section 34 21 75 Traction Power Facility System Factory Functional Testing
- 43. Section 34 21 80 Traction Power System Field Acceptance Testing

1.03 MEASUREMENT AND PAYMENT

- A. Measurement: Prefabricated AC and/or DC equipment houses will be measured for payment per individual unit of house that is fabricated, factory tested, delivered to site, installed and field functioning tested in accordance with the Contract Documents.
- B. Payment: AC and/or DC equipment houses will be paid for at the Contract unit price per each individual unit of house as indicated in the Bid Schedule of the Bid Form.

1.04 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI/NEMA C12.1 Electric Meters – Code for Electricity Metering
 - 2. ANSI/ISEA Z358.1 Standard for Emergency Eyewash and Shower Equipment
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM E136 Fire Tests on Building Materials and Structures for Non-Combustibility Test
 - 2. ASTM E84 Standard Test Method Burning Characteristics of Building Materials
 - 3. ASTM B187/B187M Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes
- C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
 - 1. ASHRAE Handbook of Fundamentals, Chapter 26
 - 2. ASHRAE Publication SPCDX (Climate Data for Region X)
 - 3. ASHRAE Guideline 16, Selecting Outdoor, Return, and Relief Dampers for Air-Side Economizer Systems
 - 4. ASHRAE Guideline 24, Ventilation and Indoor Air Quality in Low-Rise Residential Buildings
- D. California Department of Industrial Relations, Division of Occupational Safety and Health (Cal/OSHA) Regulations
- E. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. IEEE C37.20.1 Metal-Enclosed Low Voltage (1,000 Vac and below, 3,200 Vdc and below) Power Circuit Breaker Switchgear

- 2. IEEE C37.20.2 Metal Clad Switchgear
- F. National Electrical Contractors Association (NECA):
 - 1. NECA 301 Standard for Installing and Testing Fiber Optic Cables
 - 2. NECA NEIS 502 Standard for Installing Industrial Lighting Systems
- G. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA PB 1 Panelboards
- H. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code
 - 2. NFPA 72 National Fire Alarm and Signaling Code
 - 3. NFPA 101 Life Safety Code
 - 4. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems
- I. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):
 - 1. Architectural Sheet Metal Manual – SMACNA
- J. Underwriters Laboratories Inc. (UL):
 - 1. UL 50 Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
 - 2. UL 67 Standard for Safety Panelboards
 - 3. UL 489 Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.05 CODES AND REGULATORY REQUIREMENTS

Comply with the following codes and regulatory requirements:

- A. Title 8, Section 5162 Emergency Eyewash and Shower Equipment
- B. Title 24, Part 2 California Building Code
- C. Title 24, Part 3 California Electrical Code
- D. Title 24, Part 4 California Mechanical Code
- E. Title 24, Part 6 California Energy Code

- F. Title 24, Part 11 Green Building Standards Code
- G. IEEE NESC National Electrical Safety Code (NESC)
- H. American with Disabilities Act (ADA)

1.06 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
 - 3. Section 01 78 23, Operation and Maintenance Data
 - 4. Section 01 79 00, Demonstration and Training
- B. Submit the following documents for equipment and materials as indicated.
 - 1. Certificates from equipment vendors verifying that equipment conforms to specified requirements
 - 2. Certification of equipment houses two-hour fire rating
 - 3. Material Safety Data Sheets (MSDS)
 - 4. Powder coating and painting process details
 - 5. Design Drawings showing house dimensions, structural and anchoring details, equipment layout, floor plan and cutouts for conduits, personnel and equipment doors and associated hardware, and elevation views of all walls from the outside and inside, with all wall mounted equipment drawn to scale.
 - 6. Installation Manuals and Drawings
 - a. Installation manuals shall include, but not be limited to the following:
 - 1) A table of contents that shall identify all pages of the manual by revision and date.
 - 2) Installation practices and procedures that the Contractor plans to use to accomplish the installation of the AC and DC equipment houses.
 - 3) A list of installation drawings by number, revision, title and approval status and a copy of each drawing reduced to B size (11 by 17 inches).
 - 4) Quality control procedures associated with the transportation and installation of the AC and DC equipment houses.
 - 5) Installation verification procedures and data sheets.
 - 6) Staging and implementation plans.
 - b. Installation Manuals shall reflect all the field modifications.

7. Heat load and heat exchange calculations showing that HVAC equipment can maintain house ambient temperatures within specified limits and in compliance to Title 24, Part 6, California Energy Code and Title 24, Part 4, California Mechanical Code.

Heating and cooling design loads shall be determined in accordance with one of the procedures described in ASHRAE Handbook of Fundamentals. Calculations shall cover all aspects of the HVAC system design and shall include heating and cooling load calculations, system capacity calculations, system pressure drop calculations, noise calculations, and equipment selections. Computer programs shall be preferred for design calculations. Capacity of HVAC equipment shall be not less than 110 percent of calculated capacity, if heating or cooling equipment with the required capacities is not available the heating capacity or cooling capacity may be increased to a maximum of 130 percent of design loads, or as limited by requirements of the CCR Title 24, Part 6, California Energy Code.

8. Structural Calculations: Refer to Contract Specifications Section 34 21 01, General Requirements for the Traction Power System for requirements.
9. Lighting Calculations for the interior spaces and exterior areas of the traction power facility.
10. Certification, to be reviewed and approved by a District appointed independent testing agency, that exterior powder coating system is a two-step process and provides five mils minimum thick weather-resistant finish on all exterior surfaces and is applied in accordance with the application instructions.
11. Certification of floor resistance to 2,500 DC circuit breaker racking operations.
12. Installation verification and field functional test documentation including procedures, data sheets, and reports per Contracts Specification Section 34 21 80, Traction Power System Field Acceptance Testing.
13. System functional test documentation including procedures, data sheets, and reports per Contracts Specification Section 34 21 80, Traction Power System Field Acceptance Testing.
14. List of recommended spare parts in accordance with Contract Specifications Section 01 78 44, Spare Parts and Maintenance Materials.
15. Operations and Maintenance manuals in accordance with Contract Specifications Section 01 78 23, Operation and Maintenance Data.
16. Training materials in accordance with Contract Specifications Section 01 79 00, Demonstration and Training.
17. Warranty Certification.

- C. Submit samples of the following:
 - 1. Equipment electrical and thermal insulation materials, their physical and electrical properties, and proposed methods of installation.
 - 2. Indoor and outdoor finishes, including certification that exterior finish is graffiti and ultra-violet (UV) resistant.
 - 3. Weatherstripping, including certification that exterior finish is graffiti and ultra-violet (UV) resistant.

1.07 QUALITY CONTROL, QUALITY ASSURANCE, AND SUPPLIER QUALIFICATIONS

- A. Refer to Contract Specifications Section 01 43 00, Quality Assurance and Section 01 45 00, Quality Control, for hardware quality assurance requirements.
- B. Manufacturer Qualifications:
 - 1. Products shall be manufactured by firms regularly engaged in manufacturing products described in this Section.
 - 2. Factory testing shall be performed by persons having five or more years of verifiable and relevant testing experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Article 1.07 in Section 34 21 70, Traction Power Facilities Installation Requirements, for requirements.
- B. Inspect AC and DC equipment houses prior to shipment and obtain appropriate certification in accordance with the requirements of the State of California related to oversize and overweight loads and other requirements as applicable.
- C. Coordinate and schedule with the applicable authorities to obtain the appropriate permits and highway and roadway transportation clearances to haul the AC and DC equipment houses to the Jobsite or to park vehicles with the AC and DC equipment houses along the public right-of-way.
- D. Equipment shall be weatherproofed for shipment. Connection openings shall be closed to prevent entrance of moisture and any foreign material during shipment and storage.
- E. Equipment shall be handled and stored in conformance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.
- F. Coordinate and schedule with the applicable third party utility service provider(s) to electrically isolate or temporarily disconnect overhead utilities (where they obstruct the pathway) along the planned haulage route to the Jobsite.

1.09 WARRANTY

- A. Warrant AC and DC houses to be free from defective materials and workmanship, water leakage and seepage, and condensation. The warranty shall be signed by the Contractor agreeing to correct system deficiencies and replace components that fail in materials or workmanship. The warranty shall be for the period between installation and the start of revenue service, and for a five year period from the date of acceptance of the AC or DC houses by the District.

1.10 GENERAL REQUIREMENTS FOR THE TRACTION POWER SYSTEM

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

PART 2 – PRODUCTS

2.01 GENERAL

- A. AC and DC equipment houses and their associated equipment shall be in separate houses.
- B. AC and DC equipment houses shall be prefabricated, climatized, self-supporting, and transportable. The houses shall be weathertight and be free from defective materials and workmanship, water leakage and seepage, and condensation.
- C. The outside height of the AC and DC equipment houses shall not exceed 12 feet, six inches or the height constraints imposed by the respective Department of Transportations through which the AC and DC equipment houses will be transported to the testing facilities and/or Jobsite.
- D. Completed AC and DC equipment houses shall be UL labeled and have a two-hour fire rating.
- E. Aisle arrangements shall be designed for optimal personnel safety, adherence to NFPA 70 and other industry codes and standards, and standard operating and maintenance procedures within the District.
- F. Unless approved by the District, do not mount equipment, conduit or wireways to the removable panels in the DC equipment houses.
- G. Placement of equipment or raceway shall not obstruct access, maintenance, or ability to replace any other equipment in the house.
- H. Placement of cooling fans in equipment enclosures shall avoid obstructions in air flow when enclosure doors are open and/or closed.
- I. Provide clearance, as prescribed by industry standards, between enclosures and components housed within enclosures.

- J. Equipment, enclosures or boxes, components, conduit, cables, conductors and fiber optic strands shall be identified and labeled per the Contract Drawings and approved vendor design documents.
- K. Fire damper at the battery room, within the DC equipment house, shall include auxiliary contacts to interface to the SCADA system.
- L. Lighting Calculations:
 - 1. In each case provide a lighting calculation of illuminance maintained on a horizontal plane, unless otherwise required herein.
 - 2. Display the results in footcandles, considering the light loss factors, in accordance with standard engineering practice.
 - 3. Take the horizontal plane at finished floor or finish grade at all locations.
 - 4. Use a calculation grid of two feet by two feet for areas up to 40 feet on a side. For larger areas use a calculation grid no greater than five feet by five feet.
 - 5. On the calculation sheet, show a lighting fixture schedule (luminaire schedule) that includes for each fixture its symbol, quantity, label, arrangement (single or double), lumens, light loss factors, and description.
 - 6. Show a calculation summary including the calculation type, units, average maximum, minimum, ratio of average to minimum, and ratio of maximum to minimum. Show the fixture mounting details, locations and mounting heights on the plan drawings for interior and exterior lighting, and show the surface reflectances and illumination levels.
 - 7. Minimum lighting levels shall be maintained when all equipment doors are opened.

2.02 HOUSE ASSEMBLIES

- A. General:
 - 1. The AC and DC equipment house frames shall utilize steel post-and-beam framing with roof purlins.
 - 2. AC and DC equipment houses shall be designed for the applicable building code live loads and lateral loads and the following additional design requirements:
 - a. In addition to roof live load of minimum of two people, design roof-supporting members to support cable trays and any other equipment that is hanging from the roof. As a minimum, this load shall be 15 pounds per square foot.
 - b. In addition to the supported equipment, design floor for a uniform live load of 100 pounds per square foot or a concentrated load of 1,000 pounds, applied anywhere and distributed over an area of one foot square.

- c. Provide additional structural supports and roof beams at the shipping splits such that each shipping section is a self-supporting structure.
 3. Form joints, locks and seams, interior and exterior, between panels of wall, floor and roof in accordance with the SMACNA Architectural Sheet Metal Manual, Figures 3-2 and 3-3, Locks and Seams Design Data or equivalent water-tight joints as approved. Seal joints with non-hardening compound suitable for indoor and outdoor applications to be compatible with metal finish as recommended by sealant manufacturer.
 4. House splits and base structures shall be electrically bonded.
 5. Provide separate battery area from the remainder of the dc equipment house with a partition wall including two doors and floor drain, as indicated. The wall shall be full height extending to the ceiling. Provide exhaust fan on the exterior wall near the ceiling and air intake on an opposing exterior wall near the floor. Provide eyewash as specified herein.
- B. Base Structure:
1. The base of the house shall be structural steel meeting requirements of Specifications Section 05 12 00, Structural Steel Framing:
 - a. The main, cross, and longitudinal tie members shall consist of structural steel channels, angles, and beams sized as required and braced and joined between shipping splits to provide adequate strength for installation and for operation.
 - b. The base channels shall be suitable for welding to leveling channels embedded in concrete.
 2. Provide lifting lugs on the base of each complete shipping section. Design base structure for each shipping section to provide adequate strength for lifting. Other components of the house shall not be permitted for lifting.
 3. Fire proof the underside of the base structure in accordance with Contract Specifications Section 07 81 16, Cementitious Fireproofing, or Contract Specifications Section 07 81 24, Intumescent Fireproofing, whichever is most appropriate.
- C. Floor Plate:
1. Floor: Wall-to-wall steel plate, designed to accommodate the layout as indicated and welded to the main, cross and tie channels. Determine thickness of the steel plate based on the floor loading. Minimum plate thickness shall be 1/4-inch.
 2. Dielectric insulating floor for DC equipment houses: The floor for DC equipment houses shall be covered with dielectric insulating material (flooring) complying with the following requirements. Install in accordance with insulating material manufacturer's written instructions.

- a. Material: Pourable non-hygroscopic insulating material, based on epoxy compound with a non-asbestos filler, Amazite or equal. Thickness shall not be less than 1/4-inch. Final floor surface shall be uniform, level, slip-resistant. Allowed variation shall be less than 1/16-inch.
 - b. The floor insulation shall not crack under the anticipated mechanical and thermal stresses during the 40-year life cycle of the house. Submit certification that floor has withstood the equivalent 2,500 operations of circuit breaker withdrawal and replacement with no degradation of floor surface.
 - c. Minimum dielectric strength of the insulating material shall not be less than 250 volts/mil. Surface resistance measured with a 5,000V megger using a six-inch square (minimum) weighted test plate with meter connected between the test plate and the DC house structure ground shall exceed 1,000 megohms.
 - d. DC equipment enclosures shall be mounted on the floor through insulating fasteners of sufficient dielectric and mechanical strength.
3. Provide floor openings as required. Design floor openings to provide access to cable vaults below and routing, internal to the house, to grounding pigtailed, as indicated. Provide exposed floor openings with electrically insulated covers to withstand equipment weight and traffic. Furnish covers with lifting handles. Floor openings for cable penetration to the switchgear shall have smooth edges to avoid damaging the cables.
 4. Provide floor for battery area with a containment to retain any electrolyte spill. Place a durable electrolyte-resistant plastic mat on the floor to protect the floor and the curb from electrolyte. Containment area shall be able to hold electrolyte from two battery cells.
 5. For AC equipment houses, the covers for the floor opening to the 34.5 kV trench below shall be non-ferrous. The covers for the floor opening in the 34.5 kV switchgear cable compartment shall have holes. Number and location of openings shall be determined and oriented per the required cable training and termination. The covers shall be split with the split running through the centerline of the holes. After cable and cover installation, the split and holes shall be vermin-proofed.
- D. Wall Assembly:
1. Walls shall be of double panel construction. Fabricate wall panels from cold-rolled or formed sheet steel meeting requirements of Specifications Section 05 40 00, Cold Formed Metal Framing as follows:
 - a. Outer wall panels: No. 14 gage minimum
 - b. Inner wall panels: No. 16 gage minimum
 2. Wall panels shall be 24-inch modules or manufacturer's standard and shall be bolted at mating flanges to maintain even tension on the panel skin, adding strength, and providing a smooth appearance.

3. Provide wall openings as required. Locate cross and longitudinal tie channels such that no loss of structural integrity is caused by these openings.
4. Interior walls, associated with the battery room shall be of similar construction to the exterior walls and shall totally enclose the battery room area.
5. Where the AC busway or conduits (serving the battery room) are routed through the battery room, seal around the wall penetrations to maintain an equivalent barrier as the wall. Unless approved by the District, do not route infrastructure through the battery room.
6. The design shall permit removal of major equipment such as switchgear cubicles and rectifiers from the houses. Removable wall panels are acceptable for this purpose.

E. Roof Assembly:

1. The roof shall be of the gable type with a slope of one in 12 or flat roof with uniform two percent slope. Rain caps shall be provided over adjacent panels to adequately drain water. Rain caps shall be overlapping inverted V, large enough to divert two inches of rain per hour.
2. Roof assembly shall consist of exterior load-carrying panel members and a false interior ceiling. Assembly shall allow for expansion and contraction and be watertight.
3. The outer roof panels shall be a flat seam or standing seam design, fabricated from the same material as the outer wall panels. Form and flash seams, splices and roof penetrations in accordance with the SMACNA Manual, Seventh Edition. Provide per reference figures from the Architectural Sheet Metal Manual as follows:
 - a. Provide expansion batten seams perpendicular to the roof ridge and at connections of shipping splits. Sections between seams shall not exceed 30 feet in any direction. Form expansion batten seams as shown in Figure 6-8, Detail 1, Batten Seam Roofs.
 - b. Form eaves at expansion batten seams as shown in Figures 5-1, Building Expansion Joints and 5-2, Expansion Joint Intersection.
 - c. Flash seams parallel to the roof ridge as shown in Figure 6-6, Standing Seam Roofs, Detail 3 or Figure 6-17, Vented and Non-Vented Ridge Caps.
 - d. Flash ridge as shown in Figure 6-6, Standing Seam Roofs, Detail 5 or Figure 6-17, Vented and Non-Vented Ridge Caps.
 - e. Flash roof penetrations as shown in Figures 8-1, 8-2, 8-3, Roof Penetration Panel(s), 8-9, Roof Penetration Flashing-Pipes, and 8-10, Roof Penetration Flashing-Structural Steel.
4. Fabricate inner ceiling panels from the same material as the inner wall panels, and install to the underside of the roof assembly.

5. Roof assembly shall provide double ceiling panels, with adequate space between panels and, between upper panel and house roof, to accommodate two thermal insulation layers.
6. Roof shall be coated with a solar reflective coating with the following minimum characteristics in accordance with Green Building Standards Code (Cal Green) Non-residential Voluntary Measures:
 - a. Maximum three-year solar reflectance greater than or equal to 0.55.
 - b. Thermal emittance greater than or equal to 0.75.

2.03 DOORS AND REMOVABLE PANELS

A. General (Doors - Entry, Equipment Access and Battery Room)

1. Doors shall swing out. Doors, except the battery room, shall have a heavy-duty door stop to hold the door in the open position. Door stop/hold unit shall hold the door in a fully opened (180 degrees for entry and equipment access). Battery room door shall open at least 90 degrees.
2. Provide weatherstripping and flashing. Weatherstripping shall be ultra-violet (UV) resistant.
3. Provide braided ground strap, 1/2 inch x 14 inches tinned plated copper with 1/4 inch x 1/2-inch stainless steel bolts and nuts installed near the top door hinge for bonding the door to the house frame. Strap shall be installed on the interior side of the door and the installation shall assure sufficient contact.
4. Provide two pairs of 4-1/2 x 4-1/2 inches, five-knuckle, concealed bearing, stainless steel hinges with non-removable pins.
5. The design of exterior walls shall include a continuous drip shield extending out by at least four inches, caulked at interface to exterior wall, located above each entry and equipment access door.
6. Exterior hardware shall be stainless steel.
7. The design of equipment access doors shall include louvers with a filtration system that does not require the door to be opened when the filters need to be changed. Changing filters shall not compromise the NEMA 3R rating.

B. Entry Doors: Provide entry doors as indicated and as specified herein:

1. Single doors size: 42 inches minimum by 96 inches.
2. Double doors size: Two x 36 inches by 96 inches.
3. House doors shall be keyed and shall have heavy-duty exit devices. The main entry door of each house shall have a card reader access control via a card reader system.

4. The door for equipment removal shall be matched with adequately sized landing pad outside, level with the interior door, to facilitate loading and unloading of equipment.
 5. Door Construction: Fabricate doors and frames of formed sheet steel, 16 gauge minimum, galvanized and shop primed, reinforced to support door closer and panic hardware. Insulate doors. Manufacturer's standard thermal insulation may be acceptable in lieu of the specified insulation subject to District approval. Double doors and frames exceeding 72 inches wide shall be 14-gauge minimum.
 6. Entry doors shall be weatherproofed.
 7. Door hardware for each door shall comply with Contract Specifications Section 28 10 01 Access Control Systems.
 8. Provide a metal awning for rain protection over all entry doors and equipment outdoor access doors. Awnings shall protrude a minimum of 18 inches and shall slope away from the building so that rainwater drains away from the door.
- C. Battery Room Doors (DC Equipment Houses): Provide battery room doors as indicated and as specified herein:
1. Battery room design shall include an exterior doorway permitting access to the battery room without accessing the DC equipment house and an interior doorway permitting access from within the DC equipment house.
 2. Battery room exterior door shall have the same characteristics and use same hardware as other house single entry doors.
 3. Single Door Size: 42 inches minimum by 96 inches.
 4. Door Construction: Fabricate doors and frames of formed sheet steel, 16 gauge minimum, galvanized and shop primed, reinforced to support door closer and door hardware.
 5. Door hardware for each door shall consist of operating handles located at working height referenced to actual finished floor surface.
 6. Unless provided in the battery room interior wall, the interior door design shall include a mechanical fire damper (located in the lower half of the door) that shall automatically close during a fire incident.
- D. Equipment Access Doors (AC Equipment House): Provide equipment access doors as indicated and as specified herein:
1. Exterior equipment access doors shall be provided at the rear of switchgear cubicles, to facilitate termination of 35 kV cables and equipment maintenance.
 2. Fabricate equipment access doors and frames of formed sheet steel, 16 gauge minimum, galvanized and shop primed, reinforced to support door closer. Doors and frames exceeding 72 inches wide shall be 14-gauge minimum.

3. Equipment access doors shall be weatherproof.
 4. Each equipment access door shall be provided with an outdoor type padlock, with all padlocks keyed alike.
 5. Exterior equipment access doors shall have padlockable operating handles located at working height referenced to actual final ground elevation at site.
- E. Removable Panels (DC Equipment House): Provide removable panels in line with each rectifier as indicated and as specified herein
1. Panel Size: Size panels doors to allow for the removal of the rectifier units (without dis-assembly).
 2. Panel Construction: Fabricate removable panels and frames of formed sheet steel, 16 gauge minimum, galvanized and shop primed, reinforced. Install and insulate panels similarly to the permanent exterior walls.
 3. Removable panels shall be weatherproof.
 4. Provide supplemental header structural supports to maintain seismic design of the DC equipment house.
 5. Secure panels to the exterior walls with tamper resistance stainless steel fasteners.
 6. Alternative placement of removable panels shall be submitted for review and approval by the District.
- F. Equipment Access Doors (DC Equipment House):
1. As an alternative to removable panels, equipment access doors sized to allow for the removal of the rectifier units (without dis-assembly) can be proposed by the Contractor for consideration and approval by the District.
 2. Door construction shall comply with the requirements specified above for equipment access doors.

2.04 WEATHERPROOFING

- A. AC and DC equipment houses shall have a NEMA 3R minimum rating.
- B. Doors, removable panels, joints, walls, roofs, floors, vents, louvers and outdoor accessories shall be weatherproofed under the wind, rain and weather conditions specified in Contract Specifications Section 34 21 01, General Requirements for the Traction Power System.
- C. Provide weatherstripping and flashing for openings such as doors and removable panels to exclude water entry under all weather conditions.

2.05 FINISHES

- A. Exterior surfaces, including roof and ventilating domes, shall be finished as noted below:
 - 1. Enclosure finish shall be treated with a galvanized coating and finished with a powder coat.
 - 2. The galvanizing coating process shall be a two-step coating process with the following characteristics:
 - a. Lower coating shall be ten percent iron-zinc alloy deposited by the hot-dip process
 - b. Lower coating weight: 60 g/m², minimum
 - c. Upper coating shall be 80 percent iron-zinc alloy electroplated deposited by the hot-dip process
 - d. Upper coating weight: three g/m², minimum
 - e. Corrosion resistant capabilities: Maximum 1/8-inch creep corrosion when vertically scribed and exposed to five percent salt fog per ASTM B117 for 1,500 hours.
 - 3. The powder coating process shall be a two-step process with the following characteristics:
 - a. Thickness: five mils, minimum
 - b. Color:
 - 1) Powder coat: Medium beige, Sherwin Williams (#PLT6-1S4) or equal.
 - 2) Wet paint color: Sherwin Williams #F63RXN28022-4337 POLANE S or equal.
 - 3) Aerosol can: Sherwin Williams #J22XXN28029-4337 or equal.
 - c. Weather, graffiti, and ultra-violet (UV) resistant
 - d. Following house assembly any areas exposed to the outside atmosphere that have been affected by cutting or welding, shall be spot galvanized with a primer that forms a dry film no less than 90 percent pure zinc. Touch-up paint shall be applied to match the powder coat finish.
- B. Provide minimum of 20 Days' notice prior to fabrication of house exterior panels for BART inspection and independent assessment of finish characteristics to determine specification compliance. Finish characteristics shall be confirmed by the BART independent inspection prior to commencement of house construction.
- C. Surfaces of equipment inside the AC and DC equipment houses shall have an ANSI 61 gray finish, in accordance with Contract Specifications Section 34 21 01, General Requirements for the Traction Power System, with a minimum thickness of two mils.

- D. Following assembly, any areas exposed to outside atmosphere that have been affected by cutting or welding shall be spot galvanized with a primer that forms a dry film of no less than 90 percent pure zinc.
- E. Painted AC and DC houses, and equipment enclosures that do not meet the specified requirements shall be repainted at no cost to the District.

2.06 THERMAL AND ACOUSTICAL INSULATION

- A. General
 - 1. Insulating materials shall have a certified classification of non-combustible as defined by ASTM E136. Flame proofing of insulating materials will not be acceptable and proof of certification shall be by one of the following:
 - a. UL label or listing
 - b. National Bureau of Standards test results
 - c. Certified test report from a nationally recognized testing laboratory
- B. Thermal Insulation
 - 1. Floor Insulation: Coated, glass-fiber insulation, one inch thick, three pounds per cubic foot (pcf) minimum density, applied with adhesive and mechanical fasteners to underside of floor plate.
 - 2. Wall, Roof and Access Door Insulation: Foil faced glass-fiber, two inches thick, three pcf minimum density with foil face facing interior, sandwiched between the inner and outer panels.
 - 3. Minimum rating of thermal insulation shall be R-13 for walls and R-38 for ceilings.
- C. Acoustical Insulation
- D. Acoustical insulation may be used to limit the maximum allowable continuous noise level produced by the equipment inside of AC and/or DC equipment house. Refer to Contract Specifications Section 34 21 01, General Requirements for the Traction Power System, for noise level constraints.

2.07 HEATING, VENTILATING AND AIR CONDITIONING

- A. General
 - 1. The AC system or HVAC system shall conform to the design requirements of ASHRAE standards and Title 24 (California Energy Code and California Mechanical Code).
 - 2. The design of the AC or HVAC shall include a control scheme, which when activated by the Fire Detection and Alarm System shall de-energize the HVAC units and annunciate an alarm locally (at the CO2's HMI) and remotely (at OCC).

3. The AC System or HVAC system shall provide a positive pressure system within the AC equipment houses and DC equipment houses (battery room excluded).

B. Design Criteria

1. Indoor and Outdoor Design Conditions

- a. Indoor temperature shall not exceed 85 degrees Fahrenheit (29 degrees Celsius) summer maximum temperature for normal (unoccupied) mode of operation. The HVAC system shall be capable of providing 72 degrees Fahrenheit (22 degrees Celsius), with HVAC equipment operating at its design capacity, during times when the house is occupied. Summer outdoor temperature shall be as specified by Title 24, Climatic Data for the region in which the house is to be located.
 - b. The HVAC system shall have a timed override option which allows the occupied mode to be initiated and then when it times out the HVAC system shall revert to the normal mode. AC and DC houses shall be positive pressured with 0.5 air changes per hour exfiltration combined with air transferred out.
 - c. Indoor temperature shall not drop below 60 degrees Fahrenheit (15 degrees Celsius). Winter outdoor temperature shall be as specified by Title 24, Climatic Data for the region in which the house is to be located.
 - d. Space relative humidity shall not exceed 55 percent.
 - e. AC or HVAC equipment shall function as closed system or maintain positive pressure in the house.
2. Indoor Heat Rate: Indoor heat rate gains shall include heat-generating equipment and components based on their design loading. Provide a minimum of two HVAC units. Design calculation shall assume one unit to be out of service.
 3. Transmission/Solar Heat Gains: Transmission heat gains through sunlit walls and roof shall be based on CLTD method in accordance with ASHRAE Handbook of Fundamentals, Chapter 26. Assume medium color roof and walls, outdoor temperature as specified in Article 2. 07B.1.a herein, and long axis oriented in the East-West direction. No credit shall be taken for heat outflow from the enclosure.
 4. Noise Criteria: Noise generated by the operating AC or HVAC equipment shall not exceed 55dB at any point along a perimeter ten feet away from the exterior outline of the enclosure.

C. Louvers: Louvers shall be in accordance with Section 08 90 00, Louvers.

D. Heating and Ventilation Equipment: Refer to Contract Specifications Section 23 34 00, HVAC Fans, and Contract Specifications Section 23 81 00, Unitary HVAC Equipment, for heating, cooling and ventilation equipment requirements.

E. Submit heat load and heat exchange calculations showing the AC system or the HVAC system can maintain the required indoor climate conditions.

Heating and cooling design loads shall be determined in accordance with one of the procedures described in ASHRAE Handbook of Fundamentals. Calculations shall cover all aspects of the HVAC system design and shall include heating and cooling load calculations, system capacity calculations, system pressure drop calculations, noise calculations, and equipment selections. Computer programs shall be preferred for design calculations. Capacity of HVAC equipment shall be not less than 110 percent of calculated capacity, if heating or cooling equipment with the required capacities is not available the heating capacity or cooling capacity may be increased to a maximum of 130 percent of design loads, or as limited by requirements of the CCR Title 24, Part 6, California Energy Code.

F. Battery Room

1. Provide a continuous operating exhaust fan (with auxiliary contacts to interface to the SCADA system) mounted to the exterior wall (close to the battery room ceiling) at the battery room in the DC equipment house.
2. Provide ventilated exhaust system with negative pressure in accordance with Title 24, Part 4, California Mechanical Code. Exhaust ducts from battery rooms shall not connect with duct systems used for other purposes. Battery room exhausts shall be ducted to the exterior of the building.
3. Provide monitoring of fan air flow or fan operating current, with auxiliary contacts to interface to the SCADA system. The air flow monitor shall be wired directly to the associated panelboard (i.e. air flow monitor plugs are prohibited). Airflow monitor shall monitor fan current level and be capable of implementing a time delayed alarm.
4. Provide hood at exterior of battery fan exhaust protect wind, direct exhaust downward. Provide gravity louvers.

2.08 EMERGENCY EYEWASH AND DRAINAGE

1. Provide permanent eyewash, in accordance with Cal/OSHA/ANSI/ISEA Z358.1, connected to a hardlined water source in the battery room of the DC equipment house.
2. Provide floor drain in accordance with Federal, State, and local ordinances in the battery room of the DC equipment house.
3. Provide removable cover to contain water during system tests.

2.09 ELECTRICAL WORK

A. Lighting

1. General

- a. Locate light fixtures to avoid interference with overhead raceways or other major wiring or blocking of the light. Do not place light fixtures directly above equipment.
 - b. Emergency light fixtures shall be wired un-switched.
 - c. Normal lighting levels shall meet the following minimums, measured at floor level within the AC and DC equipment houses and at finished grade level:
 - 1) Aisle - 50 footcandles, average, maintained
 - 2) Outdoor - five footcandles, average, maintained around doorway.
 - d. Emergency lighting levels shall be at least five footcandles (FC), average, at floor level within the AC and DC equipment houses. The minimum emergency lighting intensity shall be at least two FC at floor level within the AC and DC equipment houses and three FC on each exit door surface.
2. Provide LED lighting suspended at nine feet above finished floor in each house:
 - a. Luminaires color shall be cool white.
 - b. Provide fixtures with clear enclosures
 - c. Control interior lighting by surface-mounted three-way or four-way switches of industrial specification grade.
 3. Provide emergency lighting with self-contained charger test switch and battery sized for 90-minute operation. Emergency lighting illumination level shall be a minimum of one FC at any point at the floor level and shall conform to NFPA 101.
 4. Exterior lighting shall consist of a weatherproof, wall mounted area lighting fixture above each doorway. Fixture shall be a one-piece housing/refractor of polycarbonate. Photometrics shall provide a low glare, downward and outward light distribution. The exterior lighting shall be on a separate circuit, and shall be controlled by a switch with three-positions as follows: ON, OFF, and AUTO. In the AUTO position, the exterior lighting shall be controlled by a photoelectric cell.
 5. Provide exit light fixture above each entry doorway on interior wall above doorway.
 6. A permanent light fixture and switch shall be provided in the following equipment enclosures:
 - a. AC Switchgear Breaker and Auxiliary Cubicles (front and rear)
 - b. DC Switchgear Breaker and Auxiliary Cubicles (front & rear)
 - c. Rectifier Transformer Control Panel (front)
 - d. Rectifier (front and rear)
 - e. Negative Grounding Device (front)
 - f. C02, C03, and C04 Cabinets (front)
 7. Light fixtures shall include clear enclosures.

B. Equipment Electrical Insulation

1. Provide equipment insulation as indicated and as specified herein.
2. Submit samples of equipment insulating materials, their physical and electrical properties, and proposed methods of installation.
3. Insulating materials, when exposed to flames or electrical arcing, shall not give off toxic gases or products of combustion which are harmful to personnel or to the surrounding equipment or which will result in electrical arcing.
4. Minimum clearance between high-resistance ground equipment enclosures and solidly-grounded equipment enclosures shall be eight feet, unless indicated otherwise.
5. Where clearance from any parts of high-resistance ground equipment to walls, columns, doors, equipment or any grounded object is less than eight feet, the walls, columns, doors, equipment or grounded object shall be insulated to a height of eight feet with an insulation sheet of glastic type rated at 1,500 volts DC minimum. Provide minimum glastic thickness of 1/8 inches.
6. No gaps shall exist between electrical wall insulation and the floor or between adjacent insulation sheets. No non-insulated fittings or hardware shall protrude through or be unprotected by insulation.
7. Wall insulation protecting exposed structural wall sections shall extend at least ten feet beyond the limits of the high-resistance ground equipment.
8. Floor insulation for the high resistance grounded equipment shall cover the entire floor.
9. Provide isolation between each dc switchgear cubicle and between rectifier and dc switchgear using non-conductive structural members, to provide a minimum one-inch isolation between adjacent sections.
10. Provide non-conductive isolating collar at connection between rectifier and AC bus duct. Grounded and HRG sides shall not be able to be bridged by a person.

C. Cabling/Wiring

1. Cables and wires shall be as specified in Contract Specifications Section 34 21 50, Common Materials and Methods for Traction Power and in Contract Specifications Section 28 31 00, Fire Detection and Alarm Systems.
2. Power and control wiring, excluding Cat 6A cable, shall be stranded conductors.
3. Provide terminal blocks at both sides of shipping splits to connect wiring between shipping sections.
4. Provide and tag wires and cables required for connecting the terminal blocks of the shipping sections.

5. Provide dedicated conduits to segregate fire detection and alarm circuits.

D. Circuit Breakers and Panelboards

1. Refer to Contract Specifications Section 26 24 24, Circuit Breakers and Panelboards, for requirements.
 - a. Provide spare circuit breakers, three 20-amps and one 30-amps, in each panelboard.
 - b. Spaces: Provide a minimum of eight circuit breaker spaces in the L01 panelboard and two circuit breaker spaces in the L02 panelboard for future installation of circuit breakers. The bus in each panelboard shall extend to cover the spaces for future circuit breakers.

E. Dry-Type and Isolation Transformers

1. Refer to Contract Specifications Section 34 21 28, Auxiliary Power Transformers (Dry Type), for requirements, with the following exceptions:
 - a. Housings shall be NEMA 1 with a ventilated screen.
 - b. Unless otherwise indicated on the Contract Drawings, transformer shall be sized to provide at least 30 percent spare capacity over the initial maximum demand load.

F. Grounding

1. Ground test stations shall be provided, as indicated, along the bottom and inside wall of the AC and DC equipment houses and shall be interconnected by an insulated copper cable sized at no less than 250 kcmil.
2. Ground test station shall be shown in the Contract Drawings.
3. Provide ground test stations in the DC equipment house with non-metallic enclosures and insulate the interconnecting ground cables between test stations.
4. Grounding shall conform to the requirements specified in Contract Specifications Section 34 21 60, Grounding and Bonding for Traction Power Distribution.
5. Uniquely identify each ground test station with a wall mounted sign directly above the ground test station.

G. Wiring Devices

1. Provide one duplex, 20-ampere, 120-volt, three-wire receptacle with integral ground fault protection inside the house near each entry door. The receptacle shall be NEMA 5-20R configuration:
2. Provide an exterior GFCI, NEMA 5-20R duplex receptacle, with an enclosure that is weatherproof whether the attachment plug is inserted or not, at 18 inches above grade in the center of the "long" wall.

3. Wiring devices shall be in accordance with Contract Specifications Section 34 21 50, Common Materials and Methods for Traction Power and Contract Specifications Section 34 21 70, Traction Power Facilities Installation Requirements.

H. Conduit, Wireways, Boxes and Fittings

1. Refer to Contract Specifications Section 20 50 13, Raceway for Facility Services, for requirements.
2. Conduits within dc equipment houses except those used for fire alarm circuits shall be extra heavy-wall reinforced thermosetting resin conduit (RTRC) conduit. Fire alarm circuits shall use GRS conduit.
3. Conduits shall not be routed above dc switchgear arc chutes.

2.10 FIRE DETECTION AND ALARM SYSTEM

- A. Provide Class A type fire detection and alarm system conforming to NFPA 72, complete with ionization detectors, dual ion zone module, control panel, end-of-line device, power supplies, conductors, conduits and all other items of material and equipment required for a complete installation.
- B. Provide addressable fire alarm system panel capable of cross zone incident verification.
- C. Provide smoke and fire detectors within the AC and DC equipment houses, suitably ceiling mounted and spaced to provide as early warning as possible of the existence of a fire or smoke within the AC and/or DC equipment houses. Do not mount smoke detectors within three feet of the ceiling area above dc circuit breaker cubicles.
- D. Provide a strobe light and a smoke and fire detectors in the battery room within the DC equipment house.
- E. Locate fire alarm control panel as indicated in the Contract Drawings.
- F. Local audible indication is not required.
- G. Detectors shall not be battery powered nor shall they contain a radiation source. A combination of photoelectric and heat (fixed rate) types shall be used to provide detection of both smoke and flaming conditions.
- H. System shall provide two separate alarm contacts. One contact shall be wired to CO2 panel for remote (SCADA) and local annunciation of detector activation. The second contact shall be provided to de-energize the HVAC units.
- I. Activation of cross zone detector devices shall initiate Device 186 and 286 station lockout relays.
- J. Refer to Contract Specifications Section 28 31 00, Fire Detection and Alarm System, for additional requirements.

2.11 ACCESS CONTROL AND INTRUSION DETECTION SYSTEM

- A. Provide access control and intrusion detection system, including field devices, weatherproof covers (as applicable), boxes, control panel, end-of-line device, power supplies, conductors, conduit and all other items of material and equipment required for a complete installation.
- B. Provide intrusion detection switches at each entry and equipment access doorway. Activation of an intrusion detection switch shall annunciate at OCC or Yard Control Tower.
- C. Locate access control panel and access card readers as indicated in the Contract Drawings.
- D. Local audible indication is not required.
- E. Refer to Contract Specifications Section 28 10 01, Access Control Systems, for requirements.

2.12 CCTV EQUIPMENT

- A. Provide CCTV equipment and the associated conduits and wiring as indicated in the Contract Drawings. The equipment shall comply with the requirements of Contract Specifications Section 28 41 29, Closed Circuit Television Systems.

2.13 COMMUNICATION SYSTEMS

- A. General
 - 1. Locate equipment as indicated in the Contract Drawings.
- B. Telephone System
 - 1. Refer to Contract Specifications Section 27 30 01, Telephone Systems, for requirements.
- C. Communication Cables and Related Equipment
 - 1. Refer to Contract Specifications Section 27 13 01, Communication Cables and Related Equipment, for requirements.

2.14 MISCELLANEOUS EQUIPMENT

- A. Material for Traction Power
 - 1. Materials (e.g. relays, termination blocks, lights, resistors, fuses, fuse holders, links, conductors) – Refer to Contract Specifications Section 34 21 50, Common Materials for Traction Power, for requirements.
- B. HVAC Control Panel and Thermostats

1. Refer to Contract Specifications Section 23 09 00, Instrumentation and Control for HVAC, for requirements.

2.15 FASTENERS FOR ITEMS MOUNTED ON EXTERIOR WALLS

- A. Fastenings for items attached to the exterior walls or doors of the AC and DC equipment houses (e.g. signs, supports for conduits and meter sockets) shall use corrosion resistant blind threaded inserts and/or stainless steel hardware and appurtenances, approved by the equipment vendor for the use, to prevent corrosion or water leaks.

2.16 STATIC SIGNAGE AND IDENTIFIERS

- A. Provide hazardous/warning static signage on the exterior side of each walk-in and equipment access doorway where maintenance personnel will be exposed to energized components and/or conductors. Refer to Cal/OSHA for additional requirements.
- B. Provide the following warning signage in high contrast reflective two inch to three inch lettering permanently mounted with screws on the exterior rear side of breaker cubicles (front and rear)
 1. "Caution Shock Hazard - Various components may have retained residual operating voltages within this Breaker Cubicle"
 2. "Consider circuit energized unless electrical clearance is established."
- C. Provide equipment house and traction power substation designation signs on house exterior doors per following requirements:
 1. Make nameplates of three-ply laminated phenolic plates with bevel edges, engraved through the black face to expose the white core. Lettering shall be condensed gothic applied using a rounded or square cutter. V-shaped grooves will not be acceptable.
 2. Nameplates shall have lettering not less than four inches high. The District will specify individual traction power substation designations to be used on these signs.

2.17 STORAGE CABINET AND FURNITURES

- A. Documentation and Tool Storage Cabinet
 1. Provide a heavy-duty steel cabinet suitable for the expected small spare parts, tools, operating and maintenance manuals, design documentation, as indicated on the Contract Drawings.

B. Furniture

1. Provide a retractable wall mounted desk and two fold up chairs, as indicated on the Contract Drawings. Minimum desk dimensions shall be 36 inches wide x 24 inches deep.

2.18 FIRE EXTINGUISHERS

- A. Provide wall mounted fire extinguisher within three feet of each entry door, in accordance with Contract Specifications Section 10 40 00, Safety Specialties.
- B. Fire extinguishers shall be of the carbon dioxide type, 20-pound capacity, and shall be wall-mounted.

2.19 LIFTING HOIST

- A. Provide a permanent lifting hoist in each DC equipment house to lift the arc shoots of the DC circuit breakers .

2.20 MISCELLANEOUS MATERIALS

A. Safety Equipment

1. Refer to Contract Specifications Section 34 21 01, General Requirements for the Traction Power System, for requirements.

B. Grounding Cables

1. General
 - a. Grounding cables shall be three feet longer than needed to reach from the point of ground connection to the farthest equipment element to be grounded.
 - b. Grounding cables shall be extra flexible insulated cable.
2. AC Equipment grounds - provide two ground cable assemblies consisting of:
 - a. On the side of the grounding cable assembly to be applied to the AC equipment, provide three (3) cables each of sufficient length to reach all phase conductors. Provide ground clamp at the end of each cable.
 - b. On the side applied to the grounding connection one cable with ground clamp.
 - c. Provide Hubbell G3359, C5000337, or Cooper #133036-8AL-S6, #133042-8AL-S6 ground clamps or approved equal.
 - d. Cable shall be extra flexible, insulated, minimum 4/0.
3. DC Rectifier grounds - provide two ground cable assemblies consisting of:
 - a. On the side of the grounding cable assembly to be applied to the equipment, four (4) cables each of sufficient length to reach all phases of each incoming

delta and wye phase, and the positive and negative dc buses. Provide heavy duty clamps at the end of each cable suitable for connection to grounding knobs provided at the connection points.

- b. On the side applied to the grounding connection one cable with a suitable ground clamp.
 - c. Cable shall be extra flexible, insulated, rated at 60KA for 15 cycles.
4. DC Switchgear grounds
- a. Provide two ground cables each of sufficient length to reach between dc buses and grounding points.
 - b. Size, rating, and characteristics shall be as 2.20B.3 rectifier grounds.

C. Tools

- 1. Provide one set of tools in each AC and DC equipment house to operate and maintain the equipment.

2.21 SPARE PARTS

A. Furnish spare parts to the District in accordance with the approved spare parts list and/or as specified herein, whichever is the more restrictive for each AC and DC equipment house at each traction power facility:

- 1. Paint
 - a. Provide two gallons for each equipment house supplied AC and DC equipment houses and associated equipment enclosures.
- 2. Heating, Venting and Air Conditioning Control Panels and Thermostats
 - a. At least one thermostat per traction power facility.
 - b. Consumables (e.g. fuses, lamps, and indication lights) - At least ten percent spares of general consumables shall be provided at each traction power facility.
- 3. Electrical
 - a. Consumables (e.g. fuses, light fixtures, LED lamps, and indication lights) - At least ten percent spares of general consumables shall be provided at each traction power facility. Provide minimum two fuses of each type and size.
 - b. Conductors and Fiber Optic Strands:
 - 1) At least 20 percent spare conductors shall be provided for all single and multi-conductor factory installed control and indication cables.
 - 2) At least 20 percent spare fiber strands shall be provided for all factory installed fiber optic cables.

4. Fire Detection and Alarm System
 - a. Field devices (e.g. strobe light, smoke and fire detectors) - At least ten percent spares of field devices shall be provided at each traction power facility.
5. Refer to Contract Specifications Section 01 78 44, Spare Parts and Maintenance Materials, for additional requirements.

PART 3 – EXECUTION

3.01 FACTORY INSTALLATION

- A. Fabricate each AC and DC equipment house as a complete equipment house, with all equipment, devices, accessories and appurtenances in place for a fully functioning and operable equipment house.
- B. Install, wire, calibrate, and test, as a unit, all AC and DC house equipment specified to be mounted in the AC and DC equipment house enclosure.
- C. Components shall be mounted in accordance with the Contract requirements, manufacturers' instructions and the approved equipment vendor designs.
- D. Install equipment secure, level, plumb and in true alignment with related adjoining work
- E. The installation of the electrical insulation shall not obstruct the operation of equipment and opening/closing of enclosure and cubicle doors.
- F. Configuration of equipment and conduit installations shall not block access to any other equipment and shall allow easy access to and replacement of all house equipment and components.
- G. The design of the shipping splits and interconnection enclosures shall:
 1. Not obstruct the operation of equipment or opening/closing of enclosure and cubicle doors.
 2. Not physically make contact with DC switchgear cubicles and/or rectifier enclosures.
- H. Finished floor, within the AC and DC equipment houses, shall be flat and have no raised spots.
- I. Enclosure and cubicle doors shall operate per the design intent without hitting adjacent structures or equipment.
- J. Penetrations of exterior walls shall be covered and sealed in accordance with the equipment vendor's recommendations to ensure the integrity of the exterior walls within the specified environmental conditions and prevent water ingress.

- K. Unless otherwise recommended by the equipment vendor, attach glastic type insulation to equipment enclosures, walls, etc. with insulated hardware.
- L. Where spare circuit breaker cubicles are indicated on the Contract Drawings, provide complete and fully functional cubicles, extend buses into the cubicles, provide cable entrance and, provide power, control and indication circuits except without circuit breakers.
- M. Provide at least two - 750 kcmil ground conductors between ground and the NGD negative bus, individually routed in dedicated conduits for connection to the NGD. Cables shall be routed to two different physically separated ground connection points. Coordinate with the ground grid design.
- N. Coordinate equipment spatial and placement of power, communications and grounding requirements with the respective equipment vendors.
- O. Locate 125 V DC battery system's fused disconnect switch within the battery room.
- P. Factory installed cables, conductors and jumpers shall be in overhead and riser conduits, wireways and/or cable trays.
- Q. Structured wire management system shall be implemented for all factory installed cables, conductors and fiber optic strands. Refer to Contract Specifications Section 34 21 01, General Requirements for the Traction Power System, for additional requirements.
- R. Overhead light fixtures, conduits, wireways and cable trays shall be mounted to the AC and DC equipment house structure in accordance with the approved equipment vendor seismic design.
- S. Unused enclosure/box openings shall be sealed.
- T. Openings in enclosures shall be fitted with grommets or equivalent to prevent damage to cables and/or conductors.
- U. Complete the installation and cleaning of conduits, wireways and cable trays (inclusive of mounting hardware) before starting wire/cable installation in accordance with Contract Specifications Section 20 50 13, Raceways for Facility Services, and BART Standard Drawing TPS76.
- V. Factory installed cables, conductors, fiber strands and jumpers shall be installed as specified herein, and in accordance with Contract Specifications Section 34 21 50, Common Materials and Methods for Traction Power, per the equipment vendor requirements, and other requirements specified elsewhere in the Contract.
- W. Circuits associated with the Fire Detection and Alarm System shall be routed in dedicated conduit and boxes.
- X. Fiber optic cables run within buildings shall be routed in dedicated wireways, conduits, and boxes. This requirement also applies to fiber optic cables entering from outside of house which terminate at equipment inside the house.

- Y. Provide common wireways segmented in three sections, for power, control, and communications cables. Fiber optic cables may be accommodated in a segmented wireway with power and control cables installed in adjacent segments.
- Z. Provide two 125 V DC control power branch circuits (from separate circuit breakers) to each AC switchgear line-up and each DC switchgear line-up to provide control power to the 125 V DC control bus and to the breaker test cabinet for circuit breaker operation and for control equipment operation. Refer to Contract Specifications Section 34 21 18, AC Switchgear, and Contract Specifications Section 34 21 25, DC Switchgear, for 125 V DC control bus, circuit breaker and wiring requirements within the cubicles.
- AA. Provide dedicated LV control power branch circuit(s) to each piece of SCADA processing equipment, CO2's HMI, communications switching equipment and the fiber optic transceivers/media converters.
- BB. The following information shall be identified on equipment access doors (AC equipment house), AC switchgear cubicle doors (front), and DC switchgear cubicles (front and rear) in accordance with the approved equipment vendor design:
 - 1. Circuit breaker/auxiliary cubicle designation.
 - 2. Unit designation.
 - 3. Circuit breaker description.
- CC. All three phase LV circuits shall be phase tapped in accordance with the color coding requirements specified in Contract Specifications Section 26 05 24, Low Voltage Wires and Cables.
- DD. Install grounding connections to the ground test stations per the approved equipment vendor designs, and in accordance with Contract Specifications Section 34 21 60, Grounding and Bonding for Traction Power Facilities.
- EE. Enclosure/cubicle ground and/or bonding straps shall be of sufficient length to permit doors to operate per design intent yet not be pinched or subject to mechanical damage.
- FF. Interconnect all indication functions specified herein to the C02 cabinet for local and remote operation/monitoring in accordance with Contract Specifications Section 34 21 33, Control, Monitoring and Display Panel.
- GG. Refer to Contract Specifications Section 34 21 01, General Requirements for the Traction Power System, for additional requirements.

3.02 FACTORY ACCEPTANCE TESTING

- A. Refer to Contract Specifications Section 01 45 24, Testing Program Requirements and Contract Specifications Section 34 21 75, Traction Power Facility System Level Factory Testing, for additional requirements.

B. Design Tests:

1. One empty house of each kind (AC and DC equipment house), complete with throat connection assemblies in the case of the DC equipment house, shall be tested in accordance with the weatherproofing test for outdoor metal-enclosed switchgear of IEEE C37.20.1 and IEEE C37.20.2.

C. Production Tests:

1. General: Tests specified herein shall be performed on each fully assembled prefabricated AC and DC equipment house. Tests shall be performed with all equipment installed and wired inside the AC and DC equipment house. All equipment components installed within houses shall have successfully passed the specified design and production tests. Refer to Contract Specifications Section 34 21 75, Traction Power Facility System Level Factory Testing.

3.03 TRANSPORTATION

- A. Prepare complete AC and DC equipment houses for transport by securing or removal of all loose items.
- B. Remove and separately package interior and exterior components which are likely to be damaged in transport due to vibration, lifting, and bumping, etc.
- C. Disconnect and remove battery cells and pack and secure in a pan for transport.
- D. Use approved spreader bar for lifting so as not to damage form, fit, or finish of equipment.
- E. Utilize the services of an experienced and fully bonded rigging contractor to perform lifting and transport of AC and DC equipment houses.

3.04 FOUNDATION COORDINATION

- A. Examine foundations, leveling channels, stairways and exposed grounding embed conditions for compliance with the approved construction design and equipment house manufacturer's requirements prior to placement of the AC and DC equipment houses.
- B. Note items that may infringe on the necessary clearances and other non-compliances. Promptly bring noted issues to the attention of the Engineer for direction and approval before proceeding.
- C. Corrective actions, as required, shall be undertaken by the Contractor at no cost to the District.

3.05 FIELD INSTALLATION

- A. Place cranes and rigging in accordance with the approved rigging plan.

- B. Install the AC and/or DC equipment house on the foundation secure, level (with stainless steel shims (if required), plumb and in true alignment with related adjoining work.
- C. Control erection tolerance requirements so as not to impair the strength, safety, serviceability or appearance.
- D. Exercise special care during installation to avoid overloading any part of the structure. Repair or replace any item damaged due to overloading, at no cost to the District.
- E. Re-assemble shipping splits in accordance with the approved equipment vendor designs and requirements including joint and weatherproofing sections of each AC and DC equipment house.
- F. Connect raceways and circuits between shipping split sections and control circuits between equipment inside the AC or DC equipment house.
- G. Secure the AC and DC equipment houses to the leveling channel in accordance with equipment vendor's recommendations and the approved seismic design.
- H. Install grounding connections to the underground ground grid pigtails per the approved construction and/or equipment vendor designs, and in accordance with Contract Specifications Section 34 21 60, Grounding and Bonding for Traction Power Facilities.
- I. Apply waterproof, non-hardening sealing compound between the foundation and house base perimeter.
- J. Leave the AC and/or DC equipment house lifting lugs, complete with boxed hardware, in each house for future use by the District.
- K. Install conduits, wireways, cable trays (to route field installed cables / conductors) and mounting hardware within the AC and DC equipment houses in accordance with Contract Specifications Section 20 50 13, Raceways for Facility Services.
- L. Field cables, conductors and jumpers shall be installed in conduits, wireways and/or cable trays.
- M. Provide panel schedules inclusive of traction and non-traction power electrical loads.
- N. Protect floor and wall surfaces during field installation and field testing activities. Touch-up electrical insulation and finished surfaces prior to final acceptance of the AC and DC equipment houses.
- O. Refer to Contract Specifications Section 34 21 70, Traction Power Facilities Installation Requirements, for additional requirements.
- P. Interconnect all control and indication functions specified herein to the CO2 cabinet for local and remote operation/monitoring in accordance with Contract Specifications Section 34 21 33, Control, Monitoring and Display Panel.

3.06 THIRD PARTY ELECTRIC UTILITY SERVICE CONNECTION

- A. Install metering enclosure, conduits (on line side of meter), mounting hardware and pads in accordance with the approved design and the third party electric utility service provider requirements.
- B. Install conduits, mounting hardware and cables on the load side of the metering enclosure in accordance with Contract Specifications Section 20 50 13, Raceways and Facility Services, and Contract Specifications Section 26 05 24, Low Voltage Wires and Cables.
- C. Seal wall penetrations of the AC and DC equipment houses in accordance with the manufacturer's requirements.

3.07 FREEZE AND CONDENSATION PROTECTION

- A. Protect AC and DC equipment house interiors and equipment from freezing and/or condensation conditions by sealing openings and maintaining inside temperature above 40 degrees Fahrenheit at all times, and particularly while in transit and storage, and during the time lag between setting down on foundation and energization. For the latter, and for any time the AC and DC equipment house is stored outdoors, use the building and equipment space heaters, with power supplied from a temporary LV AC power source, to maintain the required temperature limit.

3.08 FIELD TOUCH-UP

- A. Remove paint splatters and other spots.
- B. Clean and repaint damaged interior and exterior surface coatings of the AC and/or DC equipment house and frame with the same coating system used in the factory, using touch up paint provided by the AC and/or DC equipment house manufacturer.
- C. Painting shall follow closely the recommendations of the AC and/or DC equipment house and paint manufacturers.
- D. Provide the appearance of a new installation prior to final acceptance.

3.09 INSTALLATION VERIFICATION AND FIELD FUNCTIONAL AND SYSTEM INTEGRATION TESTING

- A. Refer to Contract Specifications Section 34 21 80, Traction Power System Field Acceptance Testing, for additional requirements.
- B. As part of installation verification testing activities a circuit breaker shall be rolled out of each equipment house (at each traction power facility) onto the designated stairway landing and back into the house while allowing safe opening and closing of the door without:
 - 1. Removing door sills.

2. "Bridging" the circuit breaker on the door sill.
3. Lifting the circuit breaker in such a way as to cause mechanical damage.

Mitigate any condition inhibiting easy movement of circuit breakers into and out of equipment houses to the satisfaction of the Engineer.

3.10 CLEANING

- A. Refer to Contract Specifications Section 01 74 14, Cleaning, for additional requirements.
- B. On completion of testing, per manufacturer's written instructions, clean all AC and DC equipment houses and associated equipment. Vacuum dirt and debris. Compressed air to assist in cleaning shall not be used.

3.11 DEMONSTRATION AND TRAINING

3.12 Refer to Contract Specifications Section 01 79 00, Demonstration and Training, for additional requirements.

3.13 Contractor shall provide a factory-authorized service representative from the manufacturer for equipment demonstration and training of District's personnel to adjust, operate, and maintain the AC and DC equipment houses and associated equipment, as required by Contract Specifications Sections 01 45 24 Testing Program Requirements and 34 21 01 Traction Power General Requirements, Part 3.

3.14 CLOSEOUT PROCEDURES

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

END OF SECTION 34 21 05