Attachment A.1

DESIGN BUILD PERFORMANCE CRITERIA FOR REPLACEMENT OF SUBSTATION 3 AND 4

Solano Community College District
4000 Suisun Valley Road
Fairfield, CA 94534
RFQ # 23-001

AUGUST 17th, 2022

PROJECT OVERVIEW

This document, along with the scoping document plans, and specifications serves as bridging material to furnish prescriptive and performance criteria to qualified design/build companies bidding on the design and construction scope of this equipment replacement project.

Solano Community College District ("District") is soliciting proposals for a Design-Build Entity to:

1. Design, construct, test, commission, and place into service two new electrical substations to replace the existing substations #3 and #4.
2. Substation #3 to be located outside of the central plant and within a new fenced-in electrical yard.
3. Substation #4 to be located either within the same footprint of the existing substation or adjacent. If the substation is adjacent the existing electrical yard fencing and pad to be extended to include the new substation.
4. The DBE will prepare and submit engineered plans for DSA and Solano Community College Review and approval. Submittals for District review to include at minimum drawing and specifications at SD, 50% CD, and 100%CD levels.
5. The switchgear will include meter system for monitoring and logging electrical loads throughout the campus that are connected to the 12kV distribution system. Hardware, software, communications, and programming will be provided as part of the scope of work for this project. Provide all required interconnecting copper and fiber optic cables between devices and campus network.
6. Structural drawings with calculations for seismic, wind load, and overturning moment shall be prepared and submitted for review and approval. Structural design for the foundation and anchorage design will also be prepared and submitted for review and approval. The structural design shall be coordinated with the electrical, mechanical, and civil design and installation details.
7. Perform civil work for new duct bank installation including remove and dispose of trees, shrubs, irrigation piping, and topsoil, saw cutting of existing pavement and concrete walkways, curbs, and gutters, trenching, backfill and resurfacing activity. Complete site development for the new substations areas to perform excavation and grading in accordance with the soils report and geotechnical report recommendations. Provide fill and remove spoils from the site. Provide paving, site drainage, fencing, gates, hardscape, and landscape as required for the project.
8. Install new conduit duct banks, manholes, and pull boxes to interconnect the new 12kV switchgear feeders to the existing campus 12kV system.
9. Coordinate the design of the Substation #3 system with the Central Plant Replacement project.
10. Prepare the required power system studies and submit for District review and approval prior to release of the new switchgear for fabrication.
11. Test and commission the new switchgear and metering prior to cutting over existing loads to the new substations.
12. Schedule outages to cut over the existing campus loads to the new service and provide temporary power to maintain all campus services during cutovers and shutdowns.
13. Demolish the existing substation #3 and #4 equipment, conduit, and conductors in coordination with Campus personnel and Central Plant project.

14. Contractor responsible for selecting and working with manufacturers to meet the project completion dates.
15. Contractor responsible for all structural, geotechnical, and seismic engineering requirements.

The completed installation will provide new reliable and resilient substations that will serve the Campus needs and allow for system maintenance, construction, modifications and improvements and electrification of the campus for the next forty years.

PROJECT MANAGEMENT AND SCHEDULE

- Project management and engineering design:
  a. Prepare and submit project schedule for review and approval.
  b. Prepare and submit a schedule of values.
  c. For working documents such as schedule, meeting minutes, submittals, RFI's, ASI's, Field Instructions, directives, project tracking, assignment of responsibilities, COR logs, budget, contingency, and allowances utilize Procore (licensing provided by SCCD), or an approved document control system at cost to DBE.
  d. Final and authoritative documents such as answered RFI's, final ASI's, finalized Field Instructions, approved submittals and shop drawings, past meeting minutes and weekly lookahead schedules, closeout documents (training videos, Operation & Maintenance Manuals, Attic Stock, Warranty, Specifications) will be uploaded by Division, IOR and special inspection reports, daily logs, pictures taken on site will be uploaded and archived if not daily then at end of each week to the project plan set in Procore.
  e. Schedule and attend weekly meetings during design and construction phases,
  f. Identify and comply with all regulatory requirements. Prepare and submit the documents required by each reviewer.
  g. Coordinate all street closures with Campus facilities and Campus Police prior to any street work. Provide traffic control, barricades, steel plates, and other measures and traffic management required to safely install all underground utilities in the streets and parking lots.
  h. Meet with the District representatives to access the site, conduct site assessments, collect record documents, details and data on the existing installation, including all underground systems, to become familiar with existing and future planned power sources and loads that will be connected to the 12kV main service and its distribution feeders.
  i. Evaluate the existing load on both substations and future power requirements.
  j. Coordinate the Substation #3 design and work with the Central Plant Replacement project developer.

- The total design build effort including design development phase is expected to be completed within 24 months.
- DBE is responsible to provide all temporary utilities and facilities required for Contractor use during construction including job trailer, sanitation, power, communications, security,

and other improvements. The cost for these temporary provisions for this project shall be included as part of the bid.

- Project schedule requirement:
  a. Design Development completion: 1-1/2 months from Notice To Proceed (NTP)
  b. 100% Construction Documents: 3-1/2 months from NTP
  c. Substation and switchgear submittals: 3 months from NTP
  d. District No Shutdown Periods: During Testing (DBE Selected will receive district schedule)
  e. Substantial Construction completion: August 31, 2024.
     1. Complete the remaining scope of work by September 30, 2024
  f. Project closeout: 24 months from NTP

Design -Builder is responsible for preparing and submitting the project schedule to the College in accordance with the requirements stated above and the Contract General Conditions.

REGULATORY REQUIREMENTS

The DBE team's design shall meet and comply with the requirements of this Design Build Performance Criteria and the requirements of the different Authorities and Agencies having jurisdiction for Solano Community College campus projects. A partial list of the Authorities, Agencies and Reviewers that the design build team shall coordinate with and gain approval from, including the following activities (as required):

- Scheduling and attending meetings
- Preparing design and construction presentations and submittals
- Responding to questions
- Completing and submitting required submissions in a timely manner
- Providing the necessary follow-up to ensure that recommendations or directions are appropriately addressed

Note this is not a comprehensive and complete list. The appropriate Authorities and Agencies may include municipal, county, state, regional or federal authority with which the project is involved. It is the responsibilities of the design build team to identify and confirm the required Authorities and Agencies which may require information or the filing of drawings, specifications, permits, etc., such as State Fire Marshal, Department of Water Resources, or any organization for code compliance in connection with the project.

Utilities Companies: PG&E

Local Fire Authority (LFA): The project must adhere to the Local Fire Authority as they will be the entity responding to any emergencies on the site. The design build team is responsible for meeting any local standards required by the LFA.

Division of State Architect, California: The design build team must submit plans for ACS, FLS, and structural review and approval.

Certified Access Specialist (CASp): Required to certify pedestrian crossings for accessibility compliance.

Storm Water Pollution Prevention Plan (SWPPP): The design build team shall, as required by the Agencies having jurisdiction including State and County, furnish mitigation measures including but not limited to infiltration of runoff before it reaches the storm drain system, treatment of runoff to remove oil and petroleum hydrocarbons before it enters the storm drain system, and control of peak flow discharge to provide steam channel projection. State Water Board and the County of Solano requirements can be accessed on the Water Board website. For provision of these mitigation measures plans, calculations, maintenance requirements must be included in the Design Development phase deliverable, details of the mitigation facilities shall be included in the Construction Documents, and post-construction documentation required for the project SWPPP shall be provided prior and during Construction Administration.

Regional Water Quality Control Board (RWQCB): as required.

Regional Air Quality Control Board (RAQCB): as required.

County of Solano: As required.

BUILDING CODE CRITERIA

As of the writing of this Criteria Document, the 2019 California Building Standards Code (Title 24, C.C.R.) and its amendments are in effect.

Part 1	2019 California Building Standards Administrative Code
Part 2	2019 California Building Code (CBC)
Part 3	2019 California Electrical Code (CEC)
Part 4	2019 California Mechanical Code (CMC)
Part 5	2019 California Plumbing Code (CPC)
Part 6	2019 California Energy Code
Part 9	2019 California Fire Code (CFC)
Part 11	2019 California Green Building Standards Code (CAL Green)
Part 12	2019 California Referenced Standards Code
Part 13	2019 NFPA Fire Code

Partial list of NFPA Standards as referenced at CBC Chapter 35 for California Fire Marshal (SFM) (See CBC Chapter 35 for complete list of referenced NFPA Standards and Amendments):

NFPA 17	Dry Chemical Extinguishing Systems (2017 ED)
NFPA 30	Flammable and Combustible Liquids Code (2018 ED)
NFPA 72	National Fire Alarm and Signaling Code (2019 ED with California Amendments)
NFPA 80	Fire Doors and Other Opening Protectives (2019 ED)
NFPA 101	Life Safety Code (2018 ED)
NFPA 105	Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives (2019 ED)

NFPA 170 Standard for Fire Safety and Emergency Symbols (2018 ED)
NFPA 252 Standard Methods of Fire Tests of Door Assemblies (2017 ED)

See CBC Chapter 35 for complete list of amendments to ASTM and UL Standards. Title 19 C.C.R. State Fire Marshal Regulations (Partial List, Title 19):

UL 464 Audible Signal Appliances (2016)
UL 521 Heat Detectors for Fire Protective Signaling Systems (1999 ED)
UL 1971 Signaling Devices for the Hearing Impaired (2002 ED)

STANDARDS AND GUIDELINES

See project plans and specifications for the industry standards and guidelines that are applicable to this project, including ANSI, ASHRAE, ASTM, IEC, IEEE, NEMA, NETA, and others.

(2020) Seismic Requirements

12kV Switchgear Sequence of Operations Overview

The DBE shall provide third party testing, commissioning, and training services of the installed system. Training shall be programmed and coordinated into the Construction Schedule. Training shall occur after equipment is commissioned and before it is placed into active service. Provide the College representative three weeks advance notice to witness the testing and commissioning of the equipment and to coordinate with the District personnel of training sessions.

Testing shall be performed in accordance with project specification 26 0800, and Campus approved NETA member testing firm with certified Level IV technician assigned to this project. ANSI/NETA Standard for Acceptance Test Specifications for Electrical Power Equipment and Systems shall be referenced for all testing requirements.

Field commissioning and performance testing of all equipment operation shall be coordinated and supervised by the project Design-Build Contractor Commissioning Agent in accordance with project specification 26 0801 and the CxA for each system.

The design build contractor shall submit testing and commissioning plans for approval prior to implementation. Commissioning activity will be witnessed by Campus IOR, Campus Representatives and Project EOR. After all testing and commissioning activities are completed and accepted, provide the testing report and commissioning reports as required for project closeout.

Equipment and systems training sessions shall be presented by each major equipment manufacturer as detailed in the project specifications, for all systems. Training shall include written material specific to this project, that includes operating manual references, regular maintenance and scheduled service requirements for inspection, proper operation checklist, measured and metered values and adjustments, tolerances, and replacement of renewable parts, fluids, or lubrication. Training will include hands-on operation of the new substations systems prior to cutover of existing campus loads so that the equipment operating conditions can be simulated without interruption of existing campus loads. DBE will film the training and will upload the training video with training materials into Procore project plan set by divisions. Provide three copies of complete digital electronic file with table of contents in PDF format on DVD or solid-state media. Provide one paper binder of training materials with table of contents for Electric Shop.

APPENDICES

Project Performance Specifications List (Refer to Campus Standards U.O.N)

DIVISION 01 – GENERAL REQUIREMENTS

- 01 1100 SUMMARY OF WORK
- 01 1400 WORK RESTRICTIONS
- 01 2100 ALLOWANCES
- 01 2200 UNIT PRICES
- 01 2300 ALTERNATES
- 01 2500 SUBSTITUTION PROCEDURES
- 01 2613 REQUEST FOR INTERPRETATION
- 01 3100 PROJECT MANAGEMENT & COORDINATION
- 01 3119 PROJECT MEETINGS
- 01 3219 SUBMITTAL SCHEDULE
- 01 3223 SURVEY AND LAYOUT DATA
- 01 3226 CONSTRUCTION PROGRESS REPORTING
- 01 3500 SPECIAL PROCEDURES
- 01 3529 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES
- 01 3543.13 ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIAL
- 01 3553 SECURITY PROCEDURES
- 01 4100 REGULATORY REQUIREMENTS
- 01 4200 REFERENCES
- 01 4500 QUALITY CONTROL
- 01 4523 TESTING AND INSPECTION SERVICES
- 01 5100 TEMPORARY UTILITIES
- 01 5200 CONSTRUCTION FACILITIES
- 01 5400 CONSTRUCTION AIDS
- 01 5500 VEHICULAR ACCESS AND PARKING
- 01 5529 STAGING AREAS
- 01 5600 TEMPORARY BARRIERS & ENCLOSURES
- 01 5639 TEMPORARY TREE & PLANT PROTECTION
- 01 5700 TEMPORARY CONTROLS
- 01 5800 PROJECT IDENTIFICATION
- 01 6000 PRODUCT REQUIREMENTS
- 01 6400 OWNER FURNISHED PRODUCTS
- 01 6500 PRODUCT DELIVERY REQUIREMENTS
- 01 6600 PRODUCT STORAGE AND HANDLING REQUIREMENTS
- 01 7100 EXAMINATION AND PREPARATION REQUIREMENTS
- 01 7300 EXECUTION
- 01 7329 CUTTING & PATCHING
- 01 7400 CLEANING AND WASTE MANAGEMENT
- 01 7500 STARTING & ADJUSTING
- 01 7700 CLOSEOUT PROCEDURES
- 01 7823 OPERATIONS AND MAINTENANCE
- 01 7836 WARRANTIES
- 01 7839 PROJECT RECORD DOCUMENTS

- 01 7900 DEMONSTRATION & TRAINING

DIVISION 02 – EXISTING CONDITIONS

- 02 3000 EARTHWORK
- 02 3200 PAVEMENT SUBBASE AND BASE COURSES
- 02 4116 DEMOLITION
- 02 5100 WATER MAINS AND SERVICES
- 02 5300 STORM AND SANITARY MANHOLES, DRAINAGE STRUCTURES, AND MISCELLANEOUS STRUCTURES
- 02 7500 ASPHALTIC CONCRETE PAVEMENT, RESURFACING AND BERMS
- 02 7510 PORTLAND CEMENT CONCRETE PAVEMENT
- 02 7520 PORTLAND CEMENT CURB, GUTTER, SIDEWALK, WALKWAY, CURB RAMP, AND DRIVEWAY

DIVISION 03 – CONCRETE

- 03 1100 CONCRETE FORMWORK
- 03 2100 CONCRETE REINFORCING STEEL
- 03 3000 CAST-IN-PLACE CONCRETE
- 03 3200 LANDSCAPE CAST-IN-PLACE CONCRETE

DIVISION 04 – MASONRY

- 04 2200 CONCRETE UNIT MASONRY

DIVISION 05 – METAL

- 05 0525 POST-INSTALLED CONCRETE ANCHORS
- 05 1200 STRUCTURAL STEEL

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

- 07 8400 FIRESTOPPING

DIVISION 08 - OPENINGS

- 08 7100 DOOR HARDWARE

DIVISION 09 – FINISHES

- 09 9113 EXTERIOR PAINTING
- 09 9713 STEEL COATINGS

DIVISION 13 – SPECIAL CONSTRUCTION

- 13 3400 FABRICATED ENGINEERED STRUCTURE

DIVISION 22 – PLUMBING

- 22 0000 GENERAL PLUMBING REQUIREMENTS
- 22 1413 STORM DRAINAGE PIPING

DIVISION 23 – HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

- 23 0500 COMMON WORK RESULTS FOR HVAC PIPING AND EQUIPMENT
- 23 0529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
- 23 0593 TESTING, ADJUSTING, AND BALANCING
- 23 0705 DUCT INSULATION
- 23 0800 MECHANICAL SYSTEMS COMMISSIONING
- 23 0913 BUILDING CONTROL SYSTEMS
- 23 2300 REFRIGERANT PIPING
- 23 3113 METAL DUCTS
- 23 3300 AIR DUCT ACCESSORIES
- 23 3423 HVAC POWER VENTILATORS
- 23 3713 DIFFUSERS, REGISTERS, AND GRILLES
- 23 8126 SPLIT SYSTEM AIR CONDITIONERS

DIVISION 26 – ELECTRICAL

- 26 0500 COMMON WORK RESULTS FOR ELECTRICAL
- 26 0501 MINOR ELECTRICAL DEMOLITION
- 26 0505 SELECTIVE DEMOLITIONS FOR ELECTRICAL
- 26 0513 MEDIUM-VOLTAGE CABLES
- 26 0519 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
- 26 0526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
- 26 0529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
- 26 0534 CONDUIT
- 26 0535 SURFACE RACEWAYS
- 26 0537 BOXES
- 26 0543 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
- 26 0548 VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
- 26 0553 IDENTIFICATION FOR ELECTRICAL SYSTEMS
- 26 0573 ELECTRICAL POWER SYSTEM STUDY
- 26 0800 ELECTRICAL TESTING REQUIREMENTS
- 26 0801 COMMISSIONING OF ELECTRICAL SYSTEMS
- 26 0914 POWER SYSTEM SCADA
- 26 1219 PADMOUNT MEDIUM-VOLTAGE TRANSFORMERS
- 26 1319 MEDIUM-VOLTAGE METAL CLAD SWITCHGEAR
- 26 2416 PANELBOARDS
- 26 2713 ELECTRICAL POWER METERING
- 26 2716 ELECTRICAL ENCLOSURES FOR CONTROL PANELS
- 26 2726 WIRING DEVICES
- 26 2813 FUSES
- 26 2817 ENCLOSED CIRCUIT BREAKERS
- 26 2818 ENCLOSED SWITCHES
- 26 3313 BATTERY
- 26 3323 EMERGENCY LIGHTING INVERTER AND BATTERY
- 26 3346 BATTERY CHARGER
- 26 5100 INTERIOR LIGHTING
- 26 5600 EXTERIOR LIGHTING

DIVISION 27 – COMMUNICATIONS

- 27 0500 COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS
- 27 0526 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
- 27 0533 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS
- 27 0543 UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS
- 26 0553 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

- 28 3100 FIRE DETECTION AND ALARM

DIVISION 31 – EARTHWORK

- 31 1000 SITE CLEARING
- 31 2200 GRADING
- 31 2313 EXCAVATION AND FILL

Project Plans

E- 0.0	COVER SHEET
E- 0.1	ABBREVIATIONS AND SYMBOLS LEGEND
E- 1.0	OVERALL SITE POWER PLAN
E- 1.1.1	Electrical Partial Site Plan (Substation #3)
E- 1.1.2	Electrical Partial Site Plan (Substation #3 – Option 2)
E- 1.2	Electrical Partial Site Plan (Substation #4)
E- 4.1	Electrical Substation #3 Plan
ED- 4.2.1	Electrical Substation #4 Plan - Demo
E- 4.1	Electrical Substation #4 Plan - New
ED- 4.2.2	Electrical Substation #4 Plan – (Option 2 – Demo)
E- 4.2.2	Electrical Substation #4 Plan – (Option 2 – New)
ED- 7.1	Electrical Single Line Diagram – Demo
E- 7.1	Electrical Single Line Diagram – New
ED- 7.2	Electrical Single Line Diagram – Demo (Substation #3 – Option 2)
E- 7.2	Electrical Single Line Diagram – Demo (Substation #3 – Option 2)

Beginning of Specifications

SECTION 02 3000 – EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Earthwork shall comply with Section 19 of the Caltrans Standard Specifications except as provide for in this Section or elsewhere in the Contract Documents. Specifically excluded from this Section is trench excavation that is covered in Alternate Section, Furnishing and Installing Pipe.

1.02 RELATED DOCUMENTS

A. Unless otherwise specified, the work embraced herein shall conform to:

1. The Contract Documents (including but not limited to plans, project geotechnical reports, and project arborist reports).
2. The appropriate specifications of the Caltrans Standard Specifications insofar as the same may apply.

B. In the event of apparent conflicts between the Standard Specifications, the Standard Plans, the Standard Details, or the Contract Documents, those requirements, as determined by the Engineer, which gives the greatest protection to the City and owner or result in the best installation shall govern.

PART 2 - GRADING

2.01 GRADE

A. The grading plane shall be as indicated in the Contract Documents. The subgrade, immediately prior to placing subsequent material thereon, shall be free of loose, deleterious and/or segregated material and shall be smooth and true to the required grade and cross sections.

2.02 GRADE TOLERANCE

A. The subgrade surface immediately prior to placing subsequent layers shall not vary more than 0.04 feet from the design elevation.

PART 3 - EXCAVATION

3.01 DESCRIPTION

A. Excavation shall comply with Section 19-2 of the Caltrans Standard Specification as far as it is applicable. Pipeline excavation is provided for in Alternate Section, Furnishing and Installing Pipe. Blasting will not be allowed unless specifically provided for in the Contract Documents.

PART 4 - EMBANKMENT CONSTRUCTION

4.01 DESCRIPTION

A. Embankment construction shall consist of constructing embankments or other areas of fill including preparation of the areas upon which embankment materials are to be placed. Material selection, compaction and slope preparation shall be as indicated in the Contract Documents.

4.02 CONSTRUCTION

A. Embankments shall be constructed in layers. The loose thickness of each layer of embankment material before compaction shall not exceed eight inches (8").

B. At the time of compaction, the moisture content of embankment material shall be such that the specified relative compaction will be obtained and the embankment will be in a firm and stable condition. Embankment material, which contains excessive moisture, shall not be compacted until the material is dry enough to obtain the required compaction. Embankment material shall not have a moisture content greater than 2% above optimum. Work necessary to dry overly wet material shall be considered incidental and is included in the prices paid for other items of work involved and no additional compensation will be allowed.

C. All areas to receive embankment construction shall have the existing surface excavated to a minimum depth of six inches (6") to remove all vegetable matter and/or other unsatisfactory material. Refer to Alternate Section, Clearing and Grubbing.

D. Embankment material shall be of a quality suitable for the purpose intended, free of vegetable matter or other unsatisfactory material. Clods or hard lumps of earth over six inches (6") in greatest dimension shall be broken up before compacting the material in embankment. Rocks over six inches (6") in greatest dimension shall be removed from embankment material.

E. When embankment is to be made and compacted against existing embankments, or where embankment is built 1/2 width at a time, the slope of old or new embankments shall be cut into a minimum of 6 feet horizontally as the work is brought up in layers.

F. The flat surfaces of all fill, placed under this Section, shall not vary more than half an inch (1/2") from the design elevations.

4.03 SLOPES

A. Excavation and embankment slopes shall be finished in conformance with the lines and grades shown in the Contract Documents or as established by the Engineer. All debris and loose material shall be removed. When completed, the average plane of the slopes shall conform to the slopes indicated in the Contract Documents and no point on the completed slopes shall vary from the designated grade by more than two and a half inches (2.5").

B. The tops of excavation slopes and the ends of excavations shall be rounded as shown in the Contract Documents or as directed by the Engineer.

4.04 UNSUITABLE MATERIAL

A. Material below the original ground surface in Earthwork areas that is judged unsuitable for the planned use by the Engineer, shall be excavated and disposed of as directed by the Engineer. Material that is overly wet but otherwise suitable shall not be considered unsuitable for the planned use (see subsection 4.2 above).

B. When unsuitable material is removed and disposed of, the resulting space shall be filled with material suitable for the planned use as determined by the Engineer. Such suitable material shall be placed and compacted in layers as noted in this Section.

C. Payment for removal and replacement of unsuitable material shall be paid at the rates approved by the City.

4.05 HAZARDOUS MATERIAL

A. The Contractor shall immediately give written notification to the owner and engineer if any of the following conditions are encountered on the project site.

1. Material that the Contractor believes may be hazardous waste.

2. Hazardous waste is defined as any material that is required to be removed to a Class I, Class II, or Class III disposal site by Section 25117 of the State Health and Safety Code.

3. Subsurface or latent physical conditions differing substantially from those indicated on the plans, specifications and/or any available soil reports, or differing substantially from conditions apparent from field operations.

4. Unknown physical conditions of any unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work required by the Contract.

5. The Contractor shall cease all work in the vicinity of the conditions encountered as described above, such that the existing conditions are not disturbed. The Contractor shall protect such site from public access or exposure.

6. Upon receipt of the above-described written notification, the owner shall promptly investigate the field conditions. If the owner determines that, due to the nature of the conditions identified in the written notification, the scope of the project has changed, the Contractor shall be directed as to any additional project requirements.

7. If the owner determines that the condition of the material encountered does not differ from the expected conditions, and is not hazardous waste, as described above, the Contractor shall proceed with the project work as provide by the contract.

PART 5 - COMPACTION

5.01 GENERAL

A. Earthwork compaction for the work consists of obtaining the required compaction in all earthwork described in the Contract Documents.

5.02 RELATIVE COMPACTION

A. The loose thickness of each layer of material before compaction shall not exceed eight inches (8") unless otherwise noted in the Contract Documents. The relative compaction of each layer shall not be less than 95%.

5.03 SUBGRADE TRUCK LOAD TEST

A. The subgrade shall be subjected to a "Truck Load Test" unless waived by the Engineer. The Contractor shall be required to furnish a loaded truck for the purpose of testing the load bearing capacity of the finished subgrade. Total gross load per rear axle shall be 16,000 pounds. Tire pressure must be over 65 psi. If the tested surface shows a visible deflection extending more than 6 inches from the wheel track at the time of loading, or a visible crack remains after loading, the Contractor shall take measures to correct the defective subgrade as approved by the Engineer.

B. In no case shall the relative compaction of the subgrade be less than required in this Section.

PART 6 - STRUCTURE EXCAVATION AND BACKFILL, IMPORTED BORROW, AND TRENCH BACKFILL

6.01 DESCRIPTION

A. Structure excavation and backfill shall comply with Section 19-3 of the Caltrans Standard Specifications as far as they are applicable and as provided in the Contract Documents. Trench backfill shall be for the backfill of pipe trenches as required in Alternate Section, Furnishing and Installing Pipe, and shall be imported material. Sand and pea gravel backfill

will not be allowed unless specifically required in the Contract Documents. Consolidating of structure backfill or pipe trench backfill by jetting or ponding is not allowed unless specifically provided for in the Contract Documents.

6.02 TRENCH BACKFILL MATERIAL AND IMPORTED BORROW

A. Trench backfill material shall consist of Class 2 Aggregate Base in accordance with Alternate Section, Aggregate Base.

B. Imported borrow shall consist of a durable granular material, well graded from coarse to fine. The combined mineral aggregate shall conform to the following gradation when determined by Test Method No. Calif. 202:

Sieve Size	Percent of Passing
1.5"	100
No.4	40-70
No. 200	0- 30

Imported borrow shall conform to the following quality requirements:

Test	Test Method	Requirements
Resistance (R-value) at	301	30 (minimum)
Sand Equivalent	217	20 (minimum)

C. The Engineer, prior to use, shall approve all imported trench backfill material and imported borrow.

6.03 SAND BACKFILL MATERIAL

A. Sand backfill will not be allowed for structure backfill or pipe trench backfill unless provided for in the Contract Documents or required by the Engineer. When sand backfill is to be used, it shall be clean and free from clay and organics. It shall be a clean, hard, durable material resulting from natural disintegration and abrasion of granite, quartz, or similar hard rock or by the processing of completely friable sandstone. It shall have a sand equivalent value of not less than 35. The percentage composition by weight as determined by laboratory sieves shall conform to the following grading limits:

Sieve Size	Percent Passing
No. 4	100
No. 10	95- 100
No. 40	20- 65
No. 100	5- 30
No. 200	0- 5

6.04 COMPACTION-IMPORTED BORROW AND TRENCH BACKFILL

A. Compaction of trench backfill shall be in accordance with Alternate Section, Furnishing and Installing Pipe.

B. Imported borrow shall be compacted to 95% relative compaction unless otherwise noted in the Contract Documents.

6.05 COMPACTION-SAND BACKFILL

A. Structural sand backfill shall be placed in loose horizontal, uniform layers not to exceed 1 foot in thickness unless otherwise specified. Method of compaction shall be by vibratory

compactors, unless otherwise specified in the Contract Documents. Each layer of sand backfill shall be compacted to a relative compaction of not less than 95 percent of maximum, as determined by Test Method No. ASTM 2922.

B. Compaction equipment and methods that produce horizontal or vertical earth pressures, which may cause excessive displacement or may damage structures, will not be allowed.

6.06 STRUCTURAL SAND BACKFILL

A. Structural sand backfill will be measured and paid by the cubic yard in place. Unless otherwise shown in the Contract Documents. The limits for computing pay quantities for structural sand backfill shall be as follows:

1. Horizontal limits will be vertical planes 1 foot outside of the neat lines of footings or structures without footings.
2. The lower limit shall be a plane at the bottom of completed footings of structures.
3. Full compensation for all incidentals arising from this work shall be considered as included in the price paid per unit of measure and no further compensation shall be allowed.

6.07 SAND TRENCH BACKFILL

A. Payment for sand trench backfill is included in the unit price of the pipe as provided in Alternate Section, Furnishing and Installing Pipe.

B. Full compensation for all incidentals arising from this work shall be considered as included in the price paid per unit of measure and no further compensation shall be allowed.

PART 7 - SURPLUS MATERIAL

7.01 DESCRIPTION

A. Surplus material from excavation shall become the property of the Contractor and be disposed of outside the limits of the Work unless otherwise shown in the Contract Documents or as directed by the Engineer.

B. Surplus material from pipe trench excavation shall become the property of the Contractor to be disposed of off the site unless the Contract Documents provide otherwise or as directed by the Engineer.

C. If the quantity of surplus material is provided in the Contract Documents, the quantity shown or specified is approximate only.

D. The Contractor shall satisfy itself that there is sufficient material available for the completion of the Work before disposing of any material. Any shortage of material caused by premature disposal of material by the Contractor, shall be replaced by the Contractor and no compensation will be allowed for such replacement.

PART 8 - TESTING

8.01 TEST METHODS

A. In connection with earthwork, tests shall be made in conformance with the following:

TEST	TEST METHOD
Relative Compaction	ASTM 2922
Maximum Density (Curve)	ASTM 1557

In-place Moisture Content	ASTM 2216
Sand Equivalent	California 217
Resistance Value (R-Value)	California 301
Sieve Analysis	California 202

END OF SECTION

SECTION 02 4116 - SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Furnishing labor, materials and equipment necessary for demolition, dismantling, cutting and alterations as indicated, specified, or required for completion of the Work. Includes items such as the following:

1. Protection of existing improvements to remain.
2. Cleaning existing improvements to remain.
3. Disconnecting and capping utilities.
4. Removing debris, waste materials, and equipment.
5. Removal of items for performance of the Work.
6. Salvageable items to be retained by the Owner.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 01 1100 - Summary of Work.
3. Section 01 5100 - Temporary Utilities
4. Section 01 5200 - Construction Facilities
5. Section 01 5700 - Temporary Controls.
6. Section 01 7000 - Execution & Closeout Requirements
6. Section 01 7329 - Cutting and Patching Requirements
7. Section 01 7419 - Construction Waste Management.
8. Division 22 –- Plumbing.
9. Division 23 –- HVAC.
10. Division 26 –- Electrical.

1.02 REFERENCE STANDARDS

A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.

1.03 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings indicating the extent of items and systems to be removed. Indicate items to be salvaged or items to be protected during demolition. Indicate locations of utility terminations and the extent of abandoned lines to be removed. Include details indicating methods and location of utility terminations.

B. Site Plan: Areas for temporary construction and field offices.

C. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.04 QUALITY ASSURANCE

A. Perform the Work of this section by workers skilled in the demolition of buildings and structures. Perform the Work of this section under direct superintendence at all times. 2021-09-05

B. Prior to commencement of Work, schedule a walkthrough with the Owner's Representative, to confirm Owner property items have been removed from scheduled Work areas. Identify and mark remaining property items and schedule their removal.

C. Coordinate demolition for the correct sequence, limits, and methods. Schedule demolition Work to create least possible inconvenience to the public and facility operations.

D. Related Standard: ANSI/ASSE A10.6.

1.05 PROJECT CONDITIONS

A. Drawings do not indicate in detail all demolition Work to be performed. Examine existing conditions to determine the full extent of required demolition.

B. Repair damage to existing improvements or damage due to excessive demolition.

C. Provide all measures to avoid excessive damage from inadequate or improper means and methods, improper shoring, bracing or support.

D. If conditions are encountered that varies from those indicated, promptly notify the Owner's Representative for clarification before proceeding.

E. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

PART 2 - PRODUCTS

2.01 HANDLING OF MATERIALS

A. Items scheduled for salvage by the Owner shall be delivered to a location designated by the Owner's Representative. Items shall be cleaned, packaged and labeled for storage.

B. Items scheduled for reuse shall be stored on the Project site and protected from damage, theft, and other deleterious conditions.

PART 3 - EXECUTION

3.01 GENERAL

A. Protection:

1. Do not commence demolition until safety partitions, barricades, warning signs and other forms of protection are installed. Refer to Section 01 5700 - Temporary Controls.

2. Provide safeguards, including warning signs, lights and barricades, for protection of workers, occupants, and the public.

B. If safety of existing construction appears to be endangered, take immediate measures to correct such conditions; cease operations and immediately notify the Owner's Representative.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Do not throw or drop materials. Furnish ramps or chutes as required by the Work.

B. Remove existing construction to the extent necessary for proper installation of Work and interfacing or joining to or with existing construction. Cut back finished surfaces to straight, plumb or level lines as required for a smooth transition.

C. Where removals are oversize or in improper locations, replace or repair to required condition.

D. Provide, erect, and maintain temporary barriers and security devices.

E. Conduct operations to minimize effects on and interference with adjacent structures and occupants.

F. Do not close or obstruct roadways or sidewalks without permit.

3.03 CUTTING EXISTING CONCRETE

A. Cutting of existing concrete shall be performed by skilled workers familiar with the requirements and space necessary for placing concrete. Perform concrete cutting with concrete cutting wheels and hand chisels. Do not damage concrete intended to remain.

B. Replace concrete demolished in excess of amounts required for new construction.

C. Prior to cutting or coring concrete, determine locations of hidden utilities or other existing improvements and provide necessary measures to protect them from damage.

3.04 REMOVAL OF OTHER MATERIALS

A. Remove existing improvements not specifically indicated or required but necessary to perform Work. Cut to clean lines, allowing for installation of Work.

B. Protect and remove existing trees as indicated on plans.

C. Remove miscellaneous concrete as indicated on plans including; Landscape Strip, and Curb, Gutter, Sidewalk at street frontage.

3.05 PATCHING

A. Patch or repair materials to remain when damaged by the performance of the Work of this section. Finish material and appearance of patch and/or repair Work shall match existing.

3.06 CLEANING

A. Clean existing materials to remain with appropriate tools and equipment.

B. Protect existing improvements during cleaning operations.

C. Debris shall be dampened by fog water spray prior to transporting by truck.

D. Debris pick-up area shall be kept broom-clean and shall be washed daily with clean water.

E. Remove waste and debris, other than items to be salvaged. Turn over salvaged items to Owner, or store and protect for reuse where required. Continuously clean up and remove items as demolition Work progresses.

F. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 02 7500 – ASPHALTIC CONCRETE PAVEMENT, RESURFACING, AND BERMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This work shall consist of furnishing and placing asphaltic concrete pavement for use in pavement, resurfacing of existing pavement, pavement repair and the construction of berms. The work includes mixing aggregate and asphalt binder at a central mixing plant, spreading and compacting the mixture, and furnishing and applying prime coat, tack coat and, when required, pavement reinforcing fabric, upon a prepared roadbed, base or over existing pavement, to the lines, grades, and dimensions shown in the Contract Documents. This item shall conform to Section 39 of the Caltrans Standard Specifications, insofar as it is applicable.

1.02 RELATED DOCUMENTS

A. Unless otherwise specified, the work embraced herein shall conform to:

1. The Contract Documents (including but not limited to plans, project geotechnical reports, and project arborist reports).

2. The appropriate specifications of the Caltrans Standard Specifications insofar as the same may apply.

B. In the event of apparent conflicts between the Standard Specifications, the Standard Plans, the Standard Details, or the Contract Documents, those requirements, as determined by the Engineer, which gives the greatest protection to the owner or result in the best installation shall govern.

PART 2 - MATERIALS

2.01 PRIME COAT

A. The prime coat shall consist of liquid asphalt SC-70 conforming to Section 93 of the Caltrans Standard Specifications and spread at the rate of 0.25 gallons per square yard of surface. Prior to placement of asphaltic concrete, the prime coat shall have attained a minimum penetration of one-quarter (1/4") inch. Paving over areas where puddling of excess un- penetrated prime coat exists shall not be allowed. Immediately in advance of placing asphaltic concrete, additional prime coat shall be applied as directed by the Engineer to areas where the prime coat has been destroyed and no additional compensation shall be allowed for this work. A sand blotter shall be applied in specific locations to the prime coat as directed by the Engineer in order to maintain vehicular and/or pedestrian traffic.

2.02 PAINT BINDER (TACK COAT)

A. Paint Binder (Tack Coat) shall be asphaltic emulsion RS1 conforming to Section 94 of the Caltrans Standard Specifications and its application shall conform to Subsection 39-4.02 of the Caltrans Standard Specifications.

2.03 MINERAL AGGREGATE

A. Coarse aggregate shall be clean, hard, tough, durable and sound. It shall be of a uniform nature and free from organic impurities or other deleterious substances. Fine aggregate shall consist of hard, durable, and sound sand. Separation of the natural material passing the No. 4 sieve from the crushed material passing the No. 4 sieve is NOT required.

B. When the combined grading of the course and fine aggregates is deficient in material passing the No. 200 sieve, a commercial filler may be added in conformance with Subsection 39-3.03 of the Standard Specifications.

C. The combined mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, shall conform to the following gradation when determined by Test Method No. Calif. 202:

Sieve Size	Base Course	Surface Course
1"	100	---
3/4"	95 - 100	100
1/2"	75-90	95-100
3/8"	65 - 80	80 - 95
No. 4	45 - 60	55 - 72
No. 8	30 - 45	38 - 55
No. 30	20 - 30	20 - 35
No. 200	3 - 7	4 - 9

2.04 ASPHALT

A. Bituminous binder shall be Performance Grade PG 70-10 asphalt conforming to Section 92 of the Caltrans Standard Specifications. Certification of the above shall be furnished to the Engineer.

B. The exact amount of asphalt binder shall be determined as provided in Section 39-2.01 of the Caltrans Standard Specifications except that the Contractor shall determine the quantity of asphalt binder per Calf. 367 and submit the mix design to the Engineer for approval.

2.05 PAVEMENT REINFORCING FABRIC AND ASPHALT BINDER

A. Pavement Reinforcing Fabric shall be placed at locations required by the Contract Documents and as required by the Engineer. Pavement reinforcing fabric shall be non-woven, bonded polypropylene-nylon, needle punched, thermally bonded on one side materials conforming to the following when tested in conformance with the listed ASTM Designation or AASHTO M288-96:

Specification	Requirement
Weight, Oz./S.Y., ASTM D3776	4.1
Grab tensile strength in pounds, ASTM	101
Elongation at break in percent, ASTM	50 Min.
Fabric Thickness in mils, ASTM D461	30 to
Mullen burst strength in psi, ASTM	200
Asphalt retention of fabric in gal/sy	0.25
ASTM D6140 oz/sy	26.9

B. The Contractor shall submit material certificate for pavement reinforcing fabric at the Preconstruction Conference for approval. If there is no Preconstruction Conference, the Contractor shall submit certification at least three (3) working days before initial placement of this material.

C. The fabric shall be protected from exposure to ultraviolet rays until placed.

2.06 PAVEMENT REINFORCING GRID

A. Pavement reinforcing grid shall be furnished and placed at all locations required by the Contract Documents and as directed by the Engineer. Pavement reinforcing grid shall be a self-adhesive, grid and conform to the following:

Specification	Requirements
Tensile strength, pounds per square inch, width and	1000 lbs./inc
Elongation at break, percent	5%
Melting point, degrees Fahrenheit	425
Adhesive Backing	Pressure
Grid Size	1 inch x

B. The Contractor shall submit material certificate and manufacturer's instructions for pavement reinforcing grid at the Preconstruction Conference to the Engineer for approval. If there is no Preconstruction Conference, submit required documents at least three (3) working days prior to initial placements.

2.07 BITUMINOUS SEALS

A. Bituminous Seals shall be of the type designated in the Contract Documents.

2.08 MISCELLANEOUS PORTLAND CEMENT CONCRETE

A. Miscellaneous Portland cement concrete is used for adjusting manholes and monuments where necessary. Miscellaneous Portland cement concrete shall be as provided in Alternate Section, Storm Sanitary Sewer Manholes, Drainage Structures, and Miscellaneous Structures, except that combined aggregate grading of 1 inch maximum shall be used.

2.09 MORTAR

A. Cement Mortar used in raising manholes and similar structures shall be composed of one part Portland cement and two (2) parts sand by volume. Sand shall be well graded and sized to all pass a #8 sieve. The materials shall be mixed to a consistency suitable for the purpose intended. Mortar shall be used within thirty (30) minutes after the mixing water has been added. Cement mortar shall achieve a minimum compressive strength of 2,000 psi in twenty-eight (28) days. The design of the cement mortar mix is subject to the approval of the Engineer.

2.10 WATER

A. Water for use in asphaltic emulsions shall conform to Section 37-2.02B of the Caltrans Standard Specifications. The source shall be approved by the Engineer. If water from the Campus potable water supply is used, the contractor must obtain a portable water meter from the Campus Water and Sewer Utility and arrange payment for water used.

B. Water for use in concrete and mortar mixes shall conform to Section 902.03 of the Caltrans Standard Specifications. To use the Campus potable water, the contractor must obtain a portable water meter from the Campus Water and Sewer Utility and arrange payment for water used.

PART 3 - ASPHALTIC CONCRETE PAVEMENT

3.01 SPREADING AND COMPACTING

Spreading and compacting of all mixtures shall conform to Subsection 396 of the Caltrans Standard Specifications, except as indicated below or in the Contract Documents.

A. SPREADING

1. All Asphaltic Pavement shall be placed with self-propelled mechanical spreading asphalt paving machines with a screed and finishing equipment. The paving machine shall be of the type in which asphalt is delivered from trucks into the paving machine. Pick-up machines shall not be allowed without written approval of the Engineer. Truck drawn portable asphalt spreaders may be used in certain areas providing prior approval is granted by the Engineer.

2. All asphaltic paving materials delivered for paving streets, drives, alleys and other public ways shall be accompanied with an official weight tag from the asphalt plant, with each load. All costs for furnishing weight tags shall be included in the cost of Asphaltic Pavement.

3. Asphaltic Pavement shall be spread and compacted in layers not to exceed two (2) inches on any surface course and shall not exceed three (3) inches on any non- surface course unless provided for in the Contract Documents. Asphaltic Pavement shall be placed to the minimum thickness required by the Contract Documents in as many lifts as required to meet the above thickness requirements. All mixtures, except open graded mixture, shall be spread at a temperature of not less than 225 degrees Fahrenheit and all initial rolling and tamping shall be performed when the temperature of the mixture is such that the sum of the air temperature plus the temperature of the mixture is between 280 degrees Fahrenheit and 375 degrees Fahrenheit. Open graded mixture shall be spread at a temperature suitable for workability. Edges shall be feathered when directed by the Engineer. A feathered edge is considered incidental and therefore no extra payment will be made.

4. All mixtures shall be placed only when the atmospheric temperature is above 50 degrees Fahrenheit.

5. No extra pay shall be allowed for cooling the asphaltic concrete with water.

6. The Contractor shall seal, and sand all conforms and edges where pavement is feathered to meet grade.

B. COMPACTING

1. Pneumatic-tire rolling shall be required only when so stated in the Special Provisions.

2. Initial or breakdown rolling shall consists of one complete coverage of asphalt mixtures and shall be performed with a tandem or a three-wheel roller. Such roller shall weigh not less than 12 tons, unless otherwise permitted by the Engineer.

3. In all other respects, spreading and compacting of all mixtures shall conform to Sub- section 39-6, Spreading and Compacting, of the Caltrans Standard Specifications.

3.02 ADJUSTMENT OF WATER VALVE BOXES

A. On new street construction or multiple course overlay of an existing street: Prior to the placement of the surface course of asphaltic pavement, water valve boxes will be raised to the elevation of the top of the base course. After the base course has been completed and before work on the surface course is commenced, the Contractor shall supply and place pre-cast rings on the valve boxes before starting the surface course. The rings will be of the proper thickness to raise the valve box to finished grade. The boxes shall be raised prior to priming. The Contractor shall be required to make any adjustments necessary for proper elevation of valve boxes. On single course overlay only: Buried water valves or those deemed by the engineer to be noticeably out of plain with the future finish grade shall have the box adjusted. All shall have adjustment rings installed per this section

3.03 ADJUSTMENT OF MANHOLES

A. Description

1. Storm drain and sanitary sewer manholes shall be constructed to the taper (cone) section. The manholes shall be covered with a temporary steel plate that is safe for traffic and does not allow dirt and debris to enter the pipe system. After the placement of the final lift of pavement, the manholes shall be brought to finish grade, installing the manhole frame and cover in accordance with the Standard Details and the Contract Documents. Comply with the provisions of Subsection 5.10 of this Section for Manhole Alteration insofar as they are applicable.

B. Other Utility Manholes

1. Manholes for other utilities such as Silicon Valley Power, PG&E, AT&T, Pacific Bell, etc., shall be raised after the final lift of pavement, by others. The Contractor shall locate and tie-out these facilities prior to paving. The Contractor shall pave over these facilities and remove a five (5") inch diameter plug of asphaltic concrete from each manhole in order that the utility can locate the manhole later.

C. Tolerance

1. The grade tolerance for adjusting all manholes and other facilities in the road shall be a maximum of 1/8 inch above to 1/4 inch below the finished grade of the final lift of asphaltic concrete. The adjusted manhole frame shall be firmly and uniformly supported using solid, durable material so that no rocking of the assembly occurs.

3.04 TESTING

A. Testing and Coring

1. Testing shall conform to the requirements of Sections 39 and 92 of the Caltrans Standard Specifications.

B. Finished Surface

1. The smoothness of the finished pavement surface shall meet the requirements of Section 39-6.03 of the Caltrans Standard Specifications.

C. Rejection

1. Any and all materials and work not conforming to the above requirements shall be corrected in a manner satisfactory to the Engineer or shall be removed from the job site at the expense of the Contractor, said material to be replaced with new material, at no cost to the Campus, conforming to the above requirements to the satisfaction of the Engineer.

PART 4 - ASPHALTIC CONCRETE PAVEMENT REPAIR

4.01 REPAIR OF POTHOLES

A. Wherever potholes appear in the area to be resurfaced or otherwise repaired, the loose material shall be removed, the asphalt pavement cut, and the sub-grade compacted so as to result in a neat, rectangular shaped area. The hole is to be painted with a paint binder (tack coat) of Grade AR 4000 paving asphalt immediately prior to placing the asphaltic concrete plug. The plug of asphaltic concrete material shall be compacted thoroughly in place, in a manner approved by the Engineer.

PART 5 - ASPHALTIC CONCRETE PAVEMENT RESURFACING

5.01 GENERAL

A. Asphaltic concrete pavement resurfacing shall consist of placing an overlay of asphaltic concrete of a specified thickness over existing pavement. The work may include repair of failed pavement; application of an asphaltic concrete leveling course; cold milling of existing pavement; application of pavement reinforcing fabric or grid; adjusting of water valve boxes, manholes and monuments; applying a layer of asphaltic concrete; applying seal coat; pre-marking and striping the street for traffic, bicyclists and pedestrians; and performing all cleanup before and after paving including removal of pavement markers, weeds and other deleterious material; and other work necessary to provide a quality finished pavement.

5.02 MATERIALS

A. Asphaltic concrete pavement materials shall be as specified in Subsection 2.0, Materials, of this Section and Section 39 of the Caltrans Standard Specifications, as applicable. Asphaltic concrete pavement for the leveling course shall be: base course using one-half (1/2") or threefourths (3/4") inch maximum size aggregate as directed by the Engineer. The final resurfacing course shall be one-half (1/2") inch maximum aggregate.

5.03 COLD MILLING PAVEMENT

A. Cold milling of pavement shall be performed where designated in the Contract Documents. Cold milling shall remove variable depths of pavement, as indicated, to provide an overlay key at joints, adjacent to gutters and over the width of the area to be cold milled. The surface of pavement after milling shall be uniformly rough grooved or ridged as directed by the Engineer. The Contractor shall remove existing asphalt concrete overlay from gutters adjacent to any area to be cold milled, as directed by the Engineer.

B. Equipment

1. The machine used for milling shall be specially designed and built for milling of bituminous pavements without the addition of heat, with the ability to plane

Portland concrete areas. The cutting drum shall be a minimum of sixty (60") inches wide and shall be equipped with carbide-tipped cutting teeth placed in a variable lacing pattern to produce the desired finish. The machine shall be capable of being operated at speeds from 0 to 40 feet per minute. It shall be self-propelled and have the capability of spraying water at the cutting drum to minimize dust. The machine shall be capable of removing the material next to the gutter of the pavement being reconditioned and be designed so that the operator can at all times observe the milling operation without leaving the controls. The machine shall be adjustable for slope and depth and shall deep cut in one pass a maximum of three (3") inches without producing fumes or smoke.

C. Removal and Disposal of Material

1. During the milling operation, the contractor shall remove loosened material from the project site, using mechanical equipment and thoroughly sweeping the street to remove any remaining material and dust. The removal crew shall follow within fifty (50') feet of the milling machine unless otherwise directed by the Engineer. The Contractor shall take all necessary measures to avoid dispersion of dust. All material removed shall be considered the property of the Contractor and shall be disposed of by the Contractor at its expense.

D. Traffic Signal Loop Detectors

1. Before cold milling pavement within three hundred (300') feet of a traffic signal, the Contractor shall notify the Campus at least seven (7) working days prior to commencing work within said area. Upon notification, the Campus will mark the location of all existing loop detectors. The Contractor shall not cold mill within twelve (12") inches of loop detector conductors or advanced loop detectors.

2. Damage to existing loops caused by the Contractor's operation will require replacement of the loops in their entirety by qualified workers at the Contractor's expense within seven (7) days of when the damage occurred.

E. Transitions

1. Milled joints that are transverse to traffic and in excess of one-half (1/2") inch in height shall be ramped with temporary asphalt concrete pavement. The ramp shall be configured so that the slope is approximately 1:12. Temporary asphaltic concrete ramps shall be placed adjacent to curb ramps for the disabled. Temporary asphaltic concrete ramps shall be installed the same day as cold milling and removed the same day as permanent paving. The Engineer shall approve transition asphaltic concrete ramp dimensions.

5.04 ASPHALTIC CONCRETE LEVELING COURSE

A. An Asphalt Concrete Leveling Course shall be applied where indicated on the plans or where directed by the Engineer. The purpose of the leveling course is to build up the pavement thickness so that the final lift of pavement will be of uniform thickness resulting in a finished surface that is smooth, has good ride-ability and is well draining and free from ruts, humps, depressions and irregularities. Asphaltic concrete for the leveling course shall be: base course using one-half (1/2") or three-fourths (3/4") inch maximum size aggregate, as directed by the Engineer and as provided in Subsection 2.0, Materials, of this Section. Paint binder (tack coat) shall be applied to areas to receive the leveling course. Application of the leveling course shall be as shown in the Contract Documents or as directed by the Engineer.

5.05 ADJUSTING WATER VALVE BOXES

A. On existing pavements where resurfacing is to be constructed, water valve boxes shall be adjusted by the Contractor. Prior to paving, the Contractor shall install one or more adjusting rings on the valve box to bring it to the finished pavement grade and tie-out each water valve box as specified in Subsection 5.10 of this Section. Because of localized deflections in the pavement, the adjustment ring or rings may not be the same height as the nominal pavement thickness.

B. Where the resurfacing or capping is done in two lifts, rings shall be placed on valve boxes to the proper elevation in advance of the construction for each lift.

C. It is important that Campus crews have access to water valves at all times in case of an emergency.

D. The Campus will furnish the adjusting rings for Contractor to install. Contractor shall coordinate with the Engineer when Contractor is ready to pick-up the adjusting rings. Payment for handling and installing adjusting rings is included in the payment for Pavement Resurfacing.

5.06 PREPARATION

A. Prior to installing asphaltic concrete leveling course, pavement reinforcing fabric, pavement reinforcing grid or resurfacing, all raised pavement markers and thermo plastic pavement markings shall be removed and the surface shall be thoroughly cleaned of dirt, debris, sand, gravel, leaves and other deleterious material. Any weeds or vegetation existing in cracks in the pavement or at the edges of gutters or other surfaces shall be removed.

B. Whenever asphaltic paving material is being placed on existing pavement, a tack coat of asphaltic emulsion shall be applied to all surfaces prior to resurfacing work, in the manner prescribed in Subsection 39-4.02 of the Standard Specifications.

5.07 PAVEMENT REINFORCING FABRIC

A. Asphalt binder for pavement reinforcing fabric shall conform to Section 92 of the Caltrans Standard Specifications and shall be Performance Grade PG 7010. Asphalt binder for pavement reinforcing fabric shall be applied at an approximate rate of 0.25 gallon minimum per square yard of surface covered. The exact rate of application shall be determined by the Engineer. The width of the asphalt binder spread shall be the width of the fabric mat plus three (3) inches on each side. Area of wedge cut shall be sprayed at a rate of 0.05 gallon per square yard first, followed by the full width spraying or 0.25 gallon per square yard, or as directed by the Engineer.

B. The fabric shall be stretched, aligned, and placed on the pavement surface with the smooth thermally bonded side up, and with no wrinkles that lap. The test for lapping shall be made by gathering together the fabric in a wrinkle. If the height of the doubled portion of extra fabric is one-half (1/2") inch or more, the fabric shall be cut to remove the wrinkle, then lapped in the direction of paving. Should the height of the doubled portion exceed two (2) inches, it shall be cut back to two (2) inches, then lapped in the direction of paving. For straight sections of roadway, no more than one fabric cut in thirty (30) linear feet of fabric laid will be allowed. For curved sections, the interval shall be ten (10) feet.

C. All areas that will receive asphaltic concrete will also have fabric installed when required by the Construction Documents or by the Engineer. These areas will include all conform areas, such as wedges at intersections and at lip of concrete gutters. Manual lay down

methods shall be used only for irregular areas that are to be paved. The fabric shall be unrolled, stretched, aligned, and placed in increments of approximately thirty (30) feet.

D. Adjacent borders of the fabric shall be lapped two (2") to four (4") inches. The preceding roll shall lap two (2") to four (4") inches over the following roll in the direction of paving at ends of rolls or at any break. At fabric overlays, both the binder and the fabric shall overlap the previously placed fabric by the same amount.

E. Seating of the fabric with rolling equipment after placing shall be permitted. Turning of the paving machine and other vehicles shall be gradual and kept to a minimum to avoid damage.

F. A small quantity of asphalt concrete, to be determined by the Engineer, may be spread over the fabric immediately in advance of placing asphalt concrete surfacing in order to prevent fabric from being picked up by construction equipment. If bleeding of asphalt binder through reinforcing fabric occurs, the Contractor shall spread a thin layer of asphalt concrete on all reinforcing fabric in place.

G. Public traffic shall not be allowed on the bare reinforcing fabric, except that public cross traffic shall be allowed to cross the fabric, under traffic control, after the Contractor has taken every effort to prevent the fabric from being displaced.

H. Care shall be taken to avoid tracking binder material onto the pavement reinforcing fabric or distorting the fabric during seating of the fabric with rolling equipment. If necessary, exposed binder material shall be covered lightly with sand.

5.08 PAVEMENT REINFORCING GRID

A. After cleaning and drying the surface, a tack coat of Performance Grade PG 70-10 asphalt conforming to Section 92 of the Caltrans Standard Specifications followed by a leveling course of asphalt concrete shall be placed as required. Asphalt concrete leveling course shall conform to Subsection 5.4, Asphalt Concrete Leveling Course, of this Section.

B. Pavement reinforcing grid shall be placed on the leveling course to the width determined by the Engineer. Placement of the pavement reinforcing grid, including longitudinal and transverse overlap limits, shall be in accordance with the manufacturer’s recommendations. The pavement surface temperature shall not be greater than 140 degrees Fahrenheit when placing the pavement reinforcing grid unless approved by the Engineer. The grid shall be laid by mechanical means or by hand with sufficient tension to eliminate wrinkles.

C. The pavement reinforcing grid and asphaltic binder may be rubber tire rolled sufficiently to activate the adhesive and to adhere the grid to the pavement surface. The reinforcing grid shall be paved with asphalt concrete on the same day it is installed.

D. All work shall be done in accordance with the manufacturer's specification.

5.09 SPREADING AND COMPACTING

A. Spreading and Compacting shall be in accordance with Subsection 3.1, Spreading and Compacting, of this Section. The Contractor shall seal and sand all conforms and edges where pavement is feathered to meet grade.

5.10 MANHOLE ALTERATION

A. The Contractor shall raise or lower manholes, flushing inlets, and catch basins not at finished grade in conformance with the Standard Details and the Contract Documents.

Unless otherwise indicated in the Contract Documents, the Contractor shall properly locate and tied off to a minimum of two (2) locations for triangulation all manholes, flushing inlets, and catch basins within the project area in advance of paving operations to the satisfaction of the Engineer. Markings shall be done by semipermanent marks of paint/ink on the concrete gutter surface nearest to the manhole, flushing inlet, or catch basin being marked. Where concrete gutter does not exist, markings shall be done as directed by the Engineer.

B. Openings of these facilities shall be covered and made safe for the public use of the roadway.

C. Where the existing frame base, frame and/or cover is judged unserviceable by the Engineer or where adjustable grade extension rings are discovered, replacement units will be provided to the Contractor by the Campus. The handling of these units shall be considered incidental work and included in the payment for other items of work involved and no additional compensation will be allowed.

D. On pre-cast manholes, the Contractor shall raise or lower the manhole frame and cover by adding or removing pre-cast concrete grade rings and grouting the manhole frame to proper grade.

E. On brick manholes, the Contractor shall raise or lower the manhole frame and cover by adding or removing the proper courses of brick and grouting the manhole frame to the proper grade. Care shall be exercised when lowering a manhole that the top of the manhole is finished to the proper diameter so that the frame shall have sufficient bearing. Blocking the frame up with wood or similar material shall not be allowed. All work shall be done as directed by the Engineer.

F. Because of the damage to vehicles using public streets and the inconvenience to the public caused by incomplete street work, the Campus will not tolerate procrastination between adjustment stages in adjusting units to grade. Once the pavement is cut and work begun, the work must be properly scheduled and diligently prosecuted so that each unit is complete to its new grade, paving in place and barricades removed (no barricading overnight), all within a two (2) Working Day period from the commencement of work in the vicinity of each unit to be adjusted. At no time shall there be a drop off greater than 0.1' (one-tenth of a foot) in the pavement overnight.

G. As a matter of public safety, the Contractor shall ensure that manhole, valve box, flush inlet, and other covers are installed on their rings anytime the opening is left unattended.

5.11 ADJUSTMENT OF SURVEY MONUMENT BOXES

A. Survey monument boxes shall be adjusted to grade prior to resurfacing if the monument has a standard box and cover and adjustment can be made with an adjustment ring. Where a monument does not have a box or where an old style square box exists, a box shall be installed after the paving operation in accordance with the Caltrans Standard Drawings. Care shall be used in working with survey monuments since they are controlled by the State of California Land Surveyor's Act. Damaged monuments that need to be replaced will need to be resurveyed by a Licensed Land Surveyor and appropriate documentation filed with the County Recorder at the expense of the contractor.

PART 6 - ASPHALTIC CONCRETE DIKES

Asphaltic Concrete dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required lines, grades and cross section.

6.01 MATERIAL

A. The combined aggregate grading for asphaltic concrete for use in dikes shall be Surface Course, one-half (1/2") inch maximum size aggregate, as specified in Subsection 2.0, Materials, of this Section. The amount of asphalt binder used for asphaltic concrete berms shall not be less than eight percent (8%) by weight of the aggregate unless otherwise indicated in the Contract Documents.

END OF SECTION

SECTION 02 7510 – PORTLAND CEMENT CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. This work shall consist of constructing Portland cement concrete pavement on a prepared subgrade as required in the Contract Documents.

B. This work shall conform to Section 40 of the Caltrans Standard Specifications except as specifically modified by the Contract Documents.

PART 2 - JOINTS

2.01 A contact joint (per CalTrans Standard Details) shall be placed at the lip of gutter, two (2') feet from the face of curb or to match the existing lip of gutter as determined by the Engineer, unless otherwise indicated and at such other points between the lips of gutters as shall be required in the Contract Documents or as determined by the Engineer.

2.02 Transverse weakened plane joints shall be placed as required in the Contract Documents or as determined by the Engineer.

PART 3 - PAVEMENT THICKNESS

3.01 Thickness of Portland Cement Concrete Pavement shall be as shown in the Contract Documents.

END OF SECTION

SECTION 03 1100 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes formwork for cast-in place concrete, with shoring, bracing, and anchorage; openings for other work; form accessories; and form stripping.

B. Related Sections:

1. Division 01: General Requirements
3. Section 03 21 00: Concrete Reinforcing Steel
4. Section 03 30 00: Cast-in-Place Concrete.
5. Division 26: Electrical.

1.02 REFERENCES

A. ACI 301 - Structural Concrete for Buildings.

B. ACI 318 - Building Code Requirements for Reinforced Concrete.

C. ACI 347 - Recommended Practice For Concrete Formwork.

D. PS 1 - Construction and Industrial Plywood.

1.03 DESIGN REQUIREMENTS

A. Design, engineer and construct formwork, shoring and bracing to conform to design and in accordance with the latest version of Title 24, Part 2, Chapter 19, "Concrete," California Building Code; resultant concrete to conform to required shape, line and dimension.

1.04 SUBMITTALS

A. Product Data: Provide data and specifications for each of the following (As Applicable):

1. Form sealer.
2. Form release compound.
3. Form ties and spreaders.
4. Manufacturer's installation instructions.
5. List of items to be provided for work of this Section.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301, ACI 318 and other applicable codes.

1.06 REGULATORY REQUIREMENTS

A. Perform Work in accordance with the latest version of Chapter 19, "Concrete," of the California Building Code, Title 24, Part 2.

B. Plywood: Conform to tables for form design and strength in APA Form V 345.

1.07 COORDINATION

A. Coordinate work under provisions of Division 01.

B. Coordinate this Section with other Sections of work which require attachment of components to formwork.

C. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from the Owner Representative.

PART 2 - PRODUCTS

2.01 WOOD FORM MATERIALS

A. General: Except as specifically noted on drawings, all forming materials shall be new material at beginning of project. Materials may be reused during progress of the job, provided they are reconditioned, recoated and are capable of producing the formwork requirements for that use.

B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.

C. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.

2.02 FORMWORK ACCESSORIES

A. Forming Ties and Spreaders:

1. Use snapties with cone spreaders or tapered formbolts and metal spreaders. Do not use wood or other absorbent material for spreaders. Ties for walls against grade shall not leave holes through entire wall section and shall break back not closer to exterior surface than 1-1/2 inches.

B. Sealer: Clear, penetrating, synthetic resin sealer.

C. Form Release Compound: Chemical, surface conversion type from coating. Reapply to cleaned forms before each reuse. Reference products:

1. "Nox-Crete Form Coating" by Nox Crete Chemicals, Inc.
2. "Release" by Burke Co.
3. "Duogard" by W.R. Meadows, Inc.
4. Or equal

D. Wood Nailing Blocks: For grounds and blocks, where permitted use Clear Douglas Fir, milled into dovetail shape, dip-treated in sealer and dried for 12 hours minimum, prior to use.

E. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size as required, of strength and character to maintain formwork in place during placement of concrete.

F. Corners: Chamfered type; size as indicated on Drawings; maximum possible lengths.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

B. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until detrimental conditions are corrected.

3.02 EARTH FORMS

A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

B. Moisten dry soil surfaces adequately to prevent leaching of moisture from wet concrete, but not so wet as to destabilize the soil surface or create ponding.

3.03 ERECTION - FORMWORK

A. Construct true to line and grade, mortar tight, sufficiently braced, tied and adequately nailed to prevent displacement, bulging or deflection, with braces and ties regularly spaced and in even rows; with provisions for anchorage or ties, sleeves and other installations; subject to approval by the Owner Representative, Contractor responsible for adequacy.

B. Erect formwork and bracing to achieve design requirements, in accordance with requirements of ACI 301 and ACI 318.

C. Provide bracing to ensure stability of formwork. Strengthen formwork subject to overstressing by construction loads.

D. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

E. Align joints and make watertight. Keep form joints to a minimum.

F. Obtain approval before framing openings in structural members which are not indicated on Drawings.

G. Provide chamfer strips where indicated on Drawings.

H. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.

I. Coordinate this section with other sections of work which require attachment of components to formwork.

J. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from the *Owner Representative*.

K. Openings For Cleaning: Provide temporary openings at all points in formwork deemed necessary by the Owner Representative to facilitate cleaning and inspection. At base of walls and wide piers, bottom form board on one face for entire length shall be omitted until form has been cleaned, inspected and accepted. Do not install board until after the Inspector’s acceptance.

3.04 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in passing through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

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

E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

3.07 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI 301.

3.08 FIELD QUALITY CONTROL

A. Comply with provisions of Division 01.

B. Inspect erected formwork and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

3.09 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads. Columns and walls shall not be stripped in less than 5 days, floor slabs in less than 7 days, beams and girders in less than 15 days. Metal pan forms for joists may be removed after 3 days, but joist centering shall not be removed until after 15 days. Ramp, landing, steps and floor slabs shall not be stripped in less than 7 days. Shoring shall not be removed until member has acquired sufficient strength to support its weight, load upon it, and added load of construction.

B. Compressive strength of in-place concrete shall be determined by testing field-cured specimens representative of concrete location or members, as specified in Section 03 30 00.

C. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

D. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION

SECTION 03 2100 - REINFORCING STEEL

PART 1 - GENERAL

1.01 SUMMARY

A. Reinforcing steel bars, wire fabric and accessories for cast-in-place concrete.

B. Related Sections:

1. Section 03 11 00: Concrete Formwork
2. Section 03 30 00: Cast-in-Place Concrete

1.02 REFERENCES

A. ACI 301 - Structural Concrete for Buildings.

B. ACI 318 - Building Code Requirements For Reinforced Concrete.

C. ACI SP- 66 - American Concrete Institute - Detailing Manual.

D. ASTM A82 - Cold Drawn Steel Wire for Concrete Reinforcement.

E. ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.

F. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

G. AWS D1.4 - Structural Welding Code for Reinforcing Steel.

H. AWS D12.1 - Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction.

I. CRSI - Concrete Reinforcing Steel Institute - Manual of Practice.

J. CRSI 63 - Recommended Practice For Placing Reinforcing Bars.

K. CRSI 65 - Recommended Practice For Placing Bar Supports, Specifications and Nomenclature.

1.03 SUBMITTALS FOR REVIEW

A. Submit under provisions of Division 01.

B. Product Data: Submit:

1. Materials list of items proposed to be provided under this Section.
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
3. Shop Drawings showing details of bars, anchors, and other items, if any, provided under this Section.
4. Manufacturer's installation procedures.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Provide the Owner Representative with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.

1.05 REGULATORY REQUIREMENTS

A. Perform Work in accordance with the latest version of Chapter 19, "Concrete," of the California Building Code, Title 24, Part 2.

1.06 QUALIFICATIONS

A. Design reinforcement under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of California.

B. Welders' Certificates: Submit under provisions of Division 01, certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.07 COORDINATION

A. Coordinate work under provisions of Division 01.

B. Coordinate with placement of formwork, formed openings and other Work.

PART 2 - PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Bars: Billet Steel, ASTM A615 or A706, locations and grades as called for on the Contract Drawings.

B. Welded Wire Fabric: ASTM A185, grades as called for on the Contract Drawings.

2.02 ACCESSORY MATERIALS

A. Steel Wire: ASTM A615; unfinished finish.

B. Bolsters, Chairs, Spacers, and Other Devices for Spacing, Supporting, and Fastening Reinforcement in Place:

1. Use wire bar type supports complying with CRSI recommendations, unless otherwise shown on the Contract Drawings.
2. Do not use wood, brick, or other non-complying material.
3. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
4. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with either hot-dip galvanized or plastic-protected legs.
5. Tie Wire: Minimum 16 gage annealed type.

C. Welding Electrodes:

1. Comply with AWS D1.4, E90XX Series.

D. Cleaning: Before placing and again before concrete is placed.

1. Remove all loose mill scale and rust.
2. Remove oil, grease, paint and any other coating that would reduce bond.

E. Dowels: ASTM A615.

2.03 FABRICATION

A. Fabricate concrete reinforcing in accordance with ACI 318.

B. Weld reinforcement in accordance with AWS D1.4.

C. Locate reinforcing splices not indicated on drawings, at point of minimum stress. Review location of splices with the Owner Representative.

PART 3 - EXECUTION

3.01 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position.

B. Do not displace or damage vapor barrier.

C. Install welded wire fabric in as long lengths as practicable, lapping adjoining pieces at least one full mesh, and lace with 16-gage tie wire.

D. Provide sufficient numbers of supports, and of strength to carry the reinforcement.

E. Do not place reinforcing bars more than 2" beyond last leg of any continuous bar support.

F. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

G. Conform to the latest version of Chapter 19, "Concrete," of the California Building Code, Title 24, Part 2, for concrete cover over reinforcement.

3.02 FIELD QUALITY CONTROL

A. Field inspection will be performed under provisions of Division 01.

END OF SECTION

SECTION 03 3000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes cast-in-place concrete ;

1. Foors and slabs on grade;

2. Control, expansion, and contraction joint devices associated with concrete work; and equipment pads..

B. Related Sections:

1. Division 01: General Requirements

2. Section 03 11 00: Concrete Formwork

3. Section 03 21 00: Reinforcing Steel

4. Division 26: Electrical Sections

1.02 REFERENCES

A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute International.

B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International.

C. ACI 301 - Structural Concrete for Buildings.

D. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International;

E. ACI 305R - Hot Weather Concreting.

F. ACI 306R - Cold Weather Concreting.

G. ACI 308 - Standard Practice for Curing Concrete.

H. ACI 318 - Building Code Requirements for Reinforced Concrete.

I. ADA - Americans with Disabilities Act.

J. ASTM C33 - Concrete Aggregates.

K. ASTM C94 - Ready-Mixed Concrete.

L. ASTM C150 - Portland Cement.

M. ASTM C260 - Air Entraining Admixtures for Concrete.

N. ASTM C494 - Chemical Admixtures for Concrete.

O. ASTM C979-82 - Standard Specification for Pigments used to Integrally Color Concrete.

P. ASTM D1190 - Concrete Joint Sealer, Hot-Poured Elastic Type.

Q. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

R. CBC - California Building Code.

1.03 SUBMITTALS FOR REVIEW

A. Submit under provisions of Division 01.

1. Mix Design: Submit mix design to the Owner Representative for review and approval.

2. Distribute approved mix design(s) to the Testing Laboratory, batch plant and to the Owner Representative.

1.04 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of embedded utilities and components which are concealed from view.

1.05 QUALITY ASSURANCE

A. Continuous inspection shall be maintained at batch plant, see Division 01, and for transit-mixed concrete to run check sieve analysis of aggregate, check moisture content of fine aggregate, check design of mix, check cement being used with test reports, check loading of mixer trucks, and certify to quantities of materials placed in each mixer truck.

B. Inspection shall be made by a representative of a Testing Laboratory selected by the Owner Representative. The Owner will pay for inspection costs. Contractor shall notify the Laboratory 24 hours in advance of time concrete is to be mixed, and shall promptly notify the Laboratory of postponement or cancellation of mixing. Contractor shall reimburse the Owner for costs incurred resulting from failure to give adequate notification of postponement or cancellation.

C. Strength test of concrete, see Division 01.

D. Acquire cement and aggregate from same source for all work.

E. Conform to ACI 305R when concreting during hot weather.

F. Conform to ACI 306R when concreting during cold weather.

G. Curing compounds and sealers shall be supplies of a single manufacturer.

H. Obtain cementitious materials from same source throughout.

I. Mixing and placing concrete, see Division 01.

J. Ready mix concrete shall be mixed and delivered in accordance with ASTM C94 and Section 1905 and other applicable sections of Chapter 19, Title 24, Part 2, CCR. Each batch of concrete delivered at job site shall be accompanied by a time slip bearing departure time and signature of batch plant supervisor. Concrete shall be placed within 90 minutes after start of mixing.

K. Store cement and aggregate materials so as to prevent their deterioration or intrusion by foreign matter. Deteriorated or contaminated materials shall not be used for concrete.

1.06 REGULATORY REQUIREMENTS

A. Perform Work in accordance with Chapter 19, "Concrete," of the California Building Code, Title 24, Part 2.

B. Perform all work in strict accordance with applicable Codes and Regulations, especially meeting all Safety Standards and Regulations of CAL/OSHA. Provide additional measures, added materials and devices as may be needed as directed by the Owner Representative at no added cost to the Owner.

1.07 COORDINATION

A. Coordinate work under provisions of Division 01.

B. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

PART 2 - PRODUCTS

2.01 GENERAL

A. Ready-Mixed Concrete: Mix and deliver in accordance with requirements of ASTM C94.

B. Strength of Concrete: All concrete shall have a minimum ultimate 28 day strength for 4000 psi mix, unless noted otherwise on structural drawings. For high-early-strength concrete, age for reaching the f'c shall be as indicated on the Drawings.

C. Maximum Size of Aggregate: ¾''.

D. Weight of Concrete: 145 pcf, air dry.

E. Slump: 4'' ± 1'', tested in accordance with ASTM C143.

F. Water/Cement Ratio: 45% max.

G. Nonstructural concrete shall have a minimum specified compression strength, f'c of 3000 psi with exposure class F1 per CBC 1904.2.

2.02 CONCRETE MATERIALS

A. Cement: "Standard Specification for Portland Cement" ASTM C150, Type II. Cement used shall correspond to that on which selection of concrete proportions was based.

B. Fine and Coarse Aggregates for Normal Concrete: ASTM C33, supplied from one source and non-reactive.

C. Water: Water shall be potable and free from deleterious matter.

D. Curing Paper and Liquid Curing Compounds:

1. Sheet curing materials to conform to ASTM C171

2. Liquid curing materials to conform to ASTM C309 (Resin Type) Class B

E. Abrasive: Aluminum Oxide grain, uniformly graded, screen size 12-13 or 16-30, "Alundum" or "Aloxite" or equal.

F. Moisture Barrier: Comply with requirements of ASTM E1747.

2.03 ADMIXTURES

A. Crystalline waterproofing complying with ASTM C143 shall be used all concrete retaining walls, and building stem walls.

B. Concrete admixture shall be a standard brand approved by the Architect and shall conform to ASTM C260 and ASTM C494. See Section 01 45 00.

2.04 ACCESSORIES

A. Bonding Agent: "Weld-Crete", manufactured by the Larsen Products Corporation or "Nitobond Acrylic" manufactured by Fosroc Inc., or equal.

B. Anti-Bonding Agent: "Thompson's Water Seal" as manufactured by A. E. Thompson, Inc., San Francisco, California or equal.

C. Vapor Retarder: Comply with requirements of ASTM E1745.

D. Non-Shrink Non-Metallic Grout: "Embeco" premixed grout as manufactured by Master Builders Company, Los Angeles, California; or "Crystex" as manufactured by L & M Construction Chemicals, Inc.; or "Por-Rok" by Hallemite Mfg. Company; or equal.

1. Compressive Strength: 8,000 psi minimum at 28 days when tested in accordance with CRD-C-621 and ASTM C 1107.

2.05 JOINT DEVICES AND FILLER MATERIALS

A. Expansion Joint Materials

1. Fiber Filler; ASTM D1751, Homex 300 manufactured by Homasote Co. distributed by Concrete Tie Co., Los Angeles, California; or "Williams Neoprene Type NN1" as manufactured by Williams Products, Inc.; or equal. Thickness as indicated on the Contract Drawings if not indicated; not less than 1/2 inch.

2. Asphaltic Sealer: ASTM D1190, Burke's No. 400 Sealing Compound, Enoco No.3074 (Polyflex), or Hunt's Seal-Flex 37, or equal.

B. Construction Joint Devices: Integral galvanized steel; formed to tongue and groove profile, with removable top strip exposing sealant trough, knockout holes spaced at 6 inches, ribbed steel spikes with tongue to fit top screwed edge.

C. Sealant and Primer: Type A two part Polyurethane Sealant – Joint Sealers.

2.06 CONCRETE MIX

A. Mix concrete in accordance with ACI 318. Deliver concrete in accordance with ASTM C94; mix design shall remain constant.

B. Use accelerating admixtures in cold weather only when approved by the Owner Representative. Use of admixtures will not relax cold weather placement requirements.

C. Use calcium chloride only when approved by the Owner Representative. Calcium chloride or admixtures containing calcium chloride shall not be used in integrally colored concrete.

D. Use set retarding admixtures during hot weather only when approved by the Owner Representative.

E. Add air entraining agent to normal weight concrete mix for work exposed to exterior.

F. Lightweight Structural Concrete: Design for air-dry density of 112 lbs. per cubic foot maximum. With each mix design, include test reports showing that concrete covered by the mix design meets shrinkage test requirements specified under Article "Quality Assurance" herein, or include certified test reports showing conformance as furnished by ready-mix concrete manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify site conditions under provisions of Division 01.

B. Verify requirements for concrete cover over reinforcement.

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

D. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

B. Where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

C. Follow details on Structural Plans for embedment of dowels in cast-in-place concrete.

D. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

3.03 PLACING CONCRETE

A. Place concrete in accordance with ACI 318 and under direct supervision of the Owner Representative. Do not place concrete outside of regular working hours, unless the Owner Representative has been notified at least 48 hours in advance and is present.

B. Notify the Owner Representative minimum 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints are not disturbed during concrete placement.

D. Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches and seal watertight by sealant applied between overlapping edges and ends.

E. Repair vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches and seal watertight.

F. Place joint filler in floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

G. Extend joint filler from bottom of slab to within 1/8 inch of finished slab surface. Conform to Section 07 92 00, for finish joint sealer requirements.

H. Install joint devices in accordance with manufacturer's instructions.

I. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

J. Install joint device anchors. Maintain correct position to allow joint cover to be flush with floor finish.

K. Install joint covers in one piece length, when adjacent construction activity is complete.

L. Apply sealants in joint devices in accordance with ASTM C804 for solvent sealants, and ASTM C962 for elastomeric sealants.

M. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

N. Concrete shall be conveyed from mixer to place of final deposit by methods which will prevent separation or loss of materials

O. Concrete shall be deposited as nearly as practicable to its final position to avoid segregation due to rehandling or flowing. No concrete that has partially hardened or been contaminated by foreign materials shall be deposited, nor shall retempered concrete or concrete which has been remixed after initial set be used.

P. Once concrete placing is started, it shall be carried on as a continuous operation until

placing of panel or section is completed. Top surfaces of vertically formed lifts shall be level.

Q. All concrete shall be thoroughly consolidated during placement, and shall be worked around reinforcement and embedded fixtures using mechanical vibrators.

3.04 CONCRETE FINISHING

A. Finish concrete surfaces to requirements as follows:

1. Float Finish: Apply float finish to monolithic slab surfaces and pads to be covered with membrane roofing.

2. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic, paint, or another thin film-finish coating system.

   a. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied floor covering system.

3. Broom Finish: Following trowel finish and prior to final cure or application of curing agents, apply light broom finish to exterior slab surfaces with strokes perpendicular to principal direction of travel.

3.05 FIELD QUALITY CONTROL

A. Molded Cylinder Tests: See Division 01.

1. The Owner Inspector shall prepare cylinders. Each cylinder shall be dated, given a number, point in structure from which sample was taken, mix design number, mix design strength and result of accompanying slump test noted.

2. Separate tests of molded concrete cylinders taken at same place and time shall be made at age of 7 days and 28 days. A strength test shall be the average of the compressive strength of 2 cylinders, made from the same sample of concrete and tested at 28 days or at test age designated for determination of f'c.

3. Test cylinders shall be made at job and stored in testing laboratory in accordance with ASTM C31, and tested in accordance with ASTM C39.

B. Core Test: At request of the Owner Inspector, cores of hardened concrete shall be cut from portions of hardened structures for testing, in accordance with ASTM C42.

1. Cores shall be taken at representative places throughout the structure as designated by the Owner Representative and shall be at least 4" in diameter.

2. In general, sufficient cores shall be taken so that knowledge will be had for all pours made. At least one core shall be taken for each 4000 square feet of building. Not less than 3 cores shall be taken from each project.

3. Where cores have been cut from work, Contractor shall fill void with drypack and patch the finish to match the adjacent existing surfaces.

C. Concrete Consistency: Measure consistency by "Standard Method of Test for Slump of Portland Cement Concrete," ASTM C143. This test shall be made by the Owner Inspector twice each day or partial day's run of the mixer.

D Adjustment of Mix: Should the strength of any grade of concrete for any portion of work, as indicated by molded test cylinders, fall below minimum 28 days compressive strength specified or indicated, the Owner Representative will direct the testing laboratory to

adjust mix for remaining portion of construction so that resulting concrete meets minimum strength requirements.

3.06 PATCHING

A. Allow Owner Representative to inspect concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify the Owner Representative upon discovery.

C. Concrete slabs which have high or low spots and are to receive resilient floor covering or soft floor covering, shall have surfaces repaired. High spots shall be honed, or ground with power-driven machines to required levels. Low spots shall be filled with latex underlayment, applied in strict accordance with manufacturer's printed instructions.

D. Holes resulting from form ties or sleeve nuts shall be solidly packed completely, through all exterior walls, by pressure grouting with cement grout, as specified. Grouted holes on exposed surfaces shall be screeded off flush and finished to match adjoining surfaces.

3.07 DEFECTIVE CONCRETE

A. Defective Concrete:

1. Should strength of any grade of concrete, for any portion of work indicated by tests of molded cylinders and core tests, fall below minimum 28 days strength specified or indicated, concrete will be deemed defective and shall be replaced or adequately strengthened in a manner acceptable to the Owner Representative.

2. Any concrete work that is not formed as indicated, is not true within 1/250th of span, not true to intended alignment, not plumb or level where so intended, not true to intended grades and levels, contains sawdust shavings, wood or embedded debris, or does not fully conform to Contract provisions, shall be deemed to be defective and shall be removed and replaced.

END OF SECTION

SECTION 03 3200 – LANDSCAPE CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes site concrete, including but not limited to pavements, stairs, walls, footings and subslabs, complete, as shown and as specified.

B. Products Installed but Not Furnished Under This Section:

1. Division 3, 03 30 00 - Cast in Place Concrete

1.02 REFERENCES

A. Standard Specifications - Standard Specifications of the State of California, Business and Transportation Agency, Department of Transportation, CALTRANS, latest edition.

B. ASTM - American Society for Testing and Materials

C. ACI - American Concrete Institute, Manual of Concrete Practice.

D. UBC - Uniform Building Code

1.03 DEFINITIONS

A. Percent Compaction: ASTM D1557, percentage of the maximum in-place dry density of the same material as determined by Soils Engineer or s outlined in the Geotechnical Investigation and Report for this project.

1.04 SUBMITTALS

A. Product Data: Manufacturers' current catalog cuts and specifications for the following:

1. Expansion joint filler, sealant, backer rod and bond breaker.
2. Waterproofing material as required by other Sections.
3. Air-entrainment.
4. Curing Compound.
5. Speed Dowels
6. Surface Retarder
7. Statement of Mix Design, prepared by the batch plant servicing the Project, for each type or load delivered to Project. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments. Each Statement of Mix Design shall include following information:
   a. Name, address, and telephone number of batch plant preparing Statement of Mix Design.
   b. Date of Mix Design.
   c. Project location.
   d. Contractor requesting load delivery.
   e. Mix Design Number.

f. Admixtures (as required).

g. Integral Color Admixtures (as required).

h. Gradations for sand and aggregate.

i. Material weights, specific gravity, and absolute volumes.

j. Basis of testing, i.e. UBC 2605 D4 and CBC Title 24 2604 D4.

k. Water/Cement Ratio.

l. Slump.

m. PSI rating

B. Certificates:

1. Reinforcing Steel: Certificate of compliance

2. Concrete Mix Design: Ticket for each batch delivered showing the following:

a. Mix identification.

b. Weight of cement, aggregate, water, and admixtures, aggregate sizes/proportion, and air entrainment.

C. LEED Submittals:

1. Product Data for Credit CR 4.1, certifying percent (by weight) of total recycled content (TRC), post- consumer (industrial recycled content).

2. MR Credit 5 for Regional Materials

3. Product Data for reinforcing steel

4. Product Data for credit CR 4.1 certify percent of Portland cement replaced by Flay Ash or Slag.

5. Product Data for credit SS 7.1, certify Paving Materials have a Solar Reflectance Index (SRI) of at least 29.

1.05 QUALITY ASSURANCE

A. Mock-up: One [1] 4 ft. x 4 ft. x 4 in. for each type of concrete finish and color to serve as standard of quality for all work. Mock-up shall include all jointing details [and insets] for acceptance.

1. Approved Mock ups shall be reserved as reference sample(s) for comparison to final installed pavements

B. Lines and Levels: To be established by a licensed Surveyor or registered Civil Engineer.

C. Mix Standards: Conform to the ACI Manual and the Portland Cement Association's "Design and Control of Concrete Mixes".

D. Design of Concrete Mix: Employ approved commercial testing laboratory to design concrete mixes as follows:

1. Minimum Compressive Strength at 28 Days:

a. Slabs or stairs On-grade: 3500 psi

2. Concrete Slump:

a. Minimum: Two [2] inches

b. Maximum: Four [4] inches

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivered Mixes: Coordinate delivery so that mixes may be immediately poured upon arrival at site.

B. Components and Accessories:

1. Fittings and Reinforcements: Protect from rust, soil and oil contamination at all times. Store on pallets above ground.

2. Templates: Protect from damage. Test accuracy prior to each use.

1.07 PROJECT/SITE CONDITIONS

A. Existing Conditions: For protection of existing plants to remain, refer to other sections.

B. Water and Dust Control: Maintain control of concrete dust and water at all times. Do not permit adjacent planting areas to be contaminated. Clean up all debris resulting from this work at the end of each day's work.

1.08 SEQUENCING AND SCHEDULING

A. Coordination: Coordinate all items of other trades to be furnished and set in place. Coordinate proper installation of all accessories embedded in the concrete and for the provision of holes, openings, etc., necessary to the execution of the work of the trades in ample time that progress of the work is not delayed.

B. Cutting/Patching: Perform as necessary to comply with above injunction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cement Aggregates and Reinforcements: Except as modified herein, conform to all applicable requirements of Section 25 "Aggregate Subbases", Section 26 "Aggregate Bases", Section 52 "Reinforcement" and Section 90, "Cement Concrete" of the Standard Specifications.

2.02 MATERIALS

A. Cement: ASTM C150, Type II Portland Cement. Use only one brand and type for entire job.

B. Normal-Weight Aggregates: Meet ASTM C33, Class 1N, and as follows:

1. Fine Aggregates: Meet ASTM C33, clean, hard, non-reactive, and durable sand. Do use sand coated with injurious amounts of silt, loam, clay or other deleterious matter.

a. Grading Requirements:

Sieve Size	Percent Passing
3/8”	100%
No. 4	95-100%
No. 8	80-100%
No. 16	50-85%

Sieve Size	Percent Passing
No. 30	25-60%
No. 50	5-30%
No. 100	0-10%

2. Coarse Aggregates: Meet ASTM C33, hard, durable, non-reactive, un-coated, graded, cleaned, and screened crushed rock or gravel aggregate for regular weight concrete. Do not use crusher-run stone or bank-run gravel. Aggregate shall be from a single source and shall be like in visual appearance.
    a. Do not use coarse Aggregate for pavements which exceeds ¾ inch diameter.
    b. Do not use coarse aggregates that contain substances that cause spalling.
3. Local aggregates not complying with ASTM C33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to the Owner's Representative.

C. Water: Per ASTM C1602, from potable domestic source, free from deleterious materials such as oils, acids, and organic matter.

D. Pozzolans:
1. Fly Ash: Meet ASTM C618, Type C or F at 20% rate by weight as cement replacement
2. Ground Granulated Iron Blast-Furnace Slag: Meet ASTM C989, Grade 100 or 120.
3. Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
    a. Boral Material Technologies Inc.
    b. Full Circle Solutions Inc.
    c. Headwater Resources, Inc.
    d. Holcim US, Inc.
    e. Lafarge North America.
    f. Mineral Resource Technologies, LLC.
    g. Mineral Solutions, Inc.
    h. The SEFA Group.
4. Source control: The Following sources of ash are not to be used:
    a. Ash from a peaking plant instead of a base loaded plant.
    b. Ash from plants burning different coals or blends of coal.
    c. Ash from plants burning other fuels (wood chips, tires, trash) blended with coal.
    d. Ash from plants using oil as a supplementary fuel.
    e. Ash from plants using precipitator additives, such as ammonia.
    f. Ash from start-up or shut-down phases of operation.

g. Ash from plants not operating at a "steady state."

h. Ash that is handled and stored using a wet system.

1) Fly ash used in concrete should be as consistent and uniform as possible. Fly ash to be used in concrete should be monitored by a quality assurance/quality control (QA/QC) program that complies with the recommended procedures in ASTM C311.(6) These procedures establish standards for methods of sampling and frequency of performing tests for fineness, loss on ignition (LOI), specific gravity, and pozzolanic activity such that the consistency of a fly ash source can be certified.

E. Water: Clean, potable concrete mixing water free from injurious amounts of salts, oils, acids, alkalis, organic materials or other deleterious matter. As available from Owner. Transport as required.

F. Air Entrainment: ASTM C260.

G. Aggregate Base for On-grade Slabs:

1. Description: Class II aggregate base shall be free from vegetable matter and other deleterious substances, and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base.

2. Grading Requirements:

Percent Passing	Sieve Size
100%	1 in.
95-100%	¾ in.
0-10%	No. 4
0-3%	No. 100

3. Quality Requirements:

a. Minimum "R" value 40

b. Max. Expansion Pressure; Calif. Test Method No. 301 100 psf

c. Maximum Plasticity Index 12

d. Sand Equivalent 20 min

2.03 CURING MATERIALS FOR WET CURE

A. Moisture-Retaining Cover: One (1) of the following, complying with ASTM C 171.

1. Polyethylene film.

2.04 ACCESSORIES

A. Reinforcements:

1. Reinforcing Bars: ASTM A615 Grade 40, or 60 deformed billet-steel bars, clean and free from rust, scale, or coating that will reduce bond.

2. Fiber Reinforcement: Collated, fibrillated, polypropylene fiber, "Fibermesh" by Fibermesh Co., (615) 892-7243.

3. Smooth Dowels for Expansion Joints: ASTM A615, Grade 40 smooth, billet-steel bars, shop painted with iron-oxide zinc-chromate primer.

4. Tie Wires: 18 ga. min. black annealed.

5. Snap Ties: Snap-off metal of fixed length capable of leaving no metal within 1 1/2 in. of surface nor causing fractures, spall or other defects larger than one [1] in. diameter.

B. Expansion Joint Materials:

1. Premolded Joint Filler: ASTM D1751, non-extruding and bituminous type resilient filler, compatible with sealant, and having a "guide strip" removable depth gauge.

2. Joint Sealant: ASTM C290, non-snag sealant "Dynatred" by Pecora Corporation, [214] 278-8158 or "Sonolastic Sealant Two-Part" by Sonneborn. Color shall be as selected. .

3. Bond Breaker: Pressure-sensitive tape as recommended by sealant manufacturer to suit application.

4. Premolded Joint Filler: "Sonoflex-F", a closed cell plastic joint filler by Sonneborn.

5. Dowels: Speed Dowel by Greenstreak: Install level with pavement surface and at midpoint of slab.

C. Forms:

1. Steel or wood of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal.

2. Use forms that are straight and free of distortions and defects.

3. Use flexible spring forms or laminated boards to form radius bends as required.

D. Form Release Agent: Colorless non-staining, free from oils. Chemical agent shall not impair bonding of paint or other proposed coatings.

E. All Surfaces: Of sufficient strength to hold concrete properly in place and prevent leakage of water from forms.

1. Exposed Surfaces: A-Matte, Two-step MDO plywood made for forming by Simpson Timber Co., [206] 292-5000 or accepted equal. No wood-textured finish will be permitted on exposed concrete unless specified as such.

2. Textured Form Facings:

F. Curing Compound: ASTM C309, Type I-D, Class A.

G. Chamfer Strips if required: Rigid PVC, 1/2 in. x 1/2 in. in maximum possible lengths.

PART 3- EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that subgrade preparation for concrete paving has been completed, including base course prior to commencement of work.

B. Surface Drainage:

1. Report in writing conflicts discovered on the site or prior work done by others, which would prevent positive drainage.

2. Do not permit finished paving surfaces to vary more than 1/4 in. measured with a 10 ft. metal straightedge, except at grade changes. No "birdbaths" or other surface irregularities will be permitted. Properly correct irregularities.

3.02 PREPARATION

A. Templates: Use templates for all anchor plates, bolts, inserts and other items embedded in concrete. Accurately secure so that they will not be displaced during placing of concrete.

B. Piping and Conduit: Do not embed piping, other than electrical conduit, in structural concrete. Locate conduit to maintain strength of structures at maximum. Verify size, length and location of electrical conduit.

C. Aggregate Base Course: Compact base course to thicknesses shown on Drawings to 95% compaction unless otherwise required by the Geotechnical Report.

3.03 INSTALLATION

A. Formwork:

1. Construct forms accurately to dimensions, plumb and true to line and grade. Brace and tie as required to maintain position and shape during placing of reinforcing and concrete.

2. Wavy surfaces and bulged walls or slab surfaces in finished work will be rejected.

3. Extend wood forms for all exposed concrete at least 6 in. below finish grade.

4. Do not disturb earth at bottoms of excavations for footings or foundations. Maintain these areas free of water, properly cleaned and leveled off.

5. Assemble forms so that all construction joints appear only as shown on Drawings. Incorporate all formwork joints into required reveal and expansion joints. No exposed form joints will be permitted.

6. Install form facings as required.

7. Use PVC chamfer strips to form chamfers at all exposed edges as shown on Drawings.

8. Thoroughly clean all formwork prior to pouring concrete. Where no form coating is used, wet down all wood.

B. Reinforcements:

1. Placement: Clean steel, bend and place reinforcements per ACI Manual of Concrete Practice. Do not extend bars through expansion joints.

2. Supports: Accurately and securely fasten or support reinforcements to prevent displacement before or during pouring. Hang footing bars from forms. Support wire mesh with suitable metal cradles.

3. Reinforcement Splices: Reinforcing bars - 24 bar diameter minimum, except as otherwise noted.

C. Joints:

1. Locations: Provide control joints at locations and intervals shown on the Drawings, and as described below. Provide expansion joints as shown and where concrete paving abuts buildings, curbs, or other structures.

2. Placement: Place expansion joint materials in proper alignment with top edge of concrete. Securely hold in place to prevent movement.

D. Placing of Concrete:

1. Preparation: Remove all free water from forms before concrete is deposited. Remove hardened concrete, debris, and foreign materials from interior surfaces of forms, exposed reinforcing, and from surfaces of mixing and conveying equipment.

2. Wetting: Wet wood forms sufficiently to tighten up cracks. Wet other materials sufficiently to reduce absorption and to help maintain concrete workability. Dampen earth sub-grade twenty-four (24)-hours before placing concrete, but do not muddy. Re-roll where necessary for smoothness, and remove loose material from compacted sub-base surface prior to placing concrete.

3. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, dowels/sleeves, and items to be embedded or cast in. Notify other trades to permit installation of their Work.

   a. Reinforcement and Forms shall be secured firmly in position such that they will not be displaced during the placement of Concrete.

   b. Reinforcement Bars, Ties, and Welded Wire Fabric shall be completely encased in concrete, at a maximum of two-inches (2”) from the edge of the concrete.

   c. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

4. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

5. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

6. Welded Wire Fabric, where specified, shall be pulled into position as the concrete is placed by means of hooks. Concrete shall be worked under the steel to .ensure that it is at the proper distance above the bottom of the slab.

7. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

   a. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

8. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments

9. When adjoining pavement lanes are placed in separate pours, do not operate equipment on existing concrete until pavement has attained 85 percent of its 28-day compressive strength. Cold-Weather Placement: Comply with ACI

306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

a. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

10. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

a. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

b. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

c. Fog-spray forms, reinforcement steel, and sub-grade just before placing concrete. Keep sub- grade moisture uniform without standing water, soft spots, or dry areas.

11. Place concrete in conformance to the ACI Manual of Concrete Practice.

E. Defective Work: Remove in its entirety and replace all defective concrete work which after corrective patching, rubbing, etc., fails to duplicate the appearance of unpatched work and/or conform to the standards set forth in these Specifications.

3.04 FINISHES

A. Broom Finish, if indicted:

1. Obtain by drawing a stiff bristled broom across a floated finish.

2. Direction of brooming to be perpendicular to direction of paving [or as shown on Drawings.]

B. Light Sand and Medium Exposed Aggregate Finishes:

1. Perform Surface Retarder Application in accordance with Manufacturer’s Recommendations. Expose Surface by using water.

2. Continuity: Perform in as continuous an operation as possible, utilizing the same work crew to maintain continuity of finish.

3. Depth of Cut: Expose the aggregate and surrounding matrix surfaces to achieve approved mock ups.

4. Power wash at 7 days after placement to clean up loose aggregate and remove efflorescence in a manner that does not dislodge aggregates.

a. Final Power wash of all concrete pavements shall be performed 2 days before project is turned over to the University.

3.05 JOINTS

A. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, buildings, foundations,

walls, other fixed objects, and in other locations as indicated on the Contract Drawings. Provide Expansion Joints at full depth of concrete pavements where pavements meet the vertical faces of buildings, structures, foundations, walls, etc.

1. Locate expansion joints at maximum intervals of twenty (20) feet, unless otherwise indicated on the Contract Drawings.
2. Extend joint fillers full width and depth of joint.
3. Provide Construction Joint Dowel Bars at the spacing distances indicated in the Contract Drawings.
4. Terminate Joint Filler less than 1/2 inch or more than one-inch (1”) below finished surface if joint sealant is indicated.
5. Place top of Joint Filler flush with finished concrete surface if joint sealant is not indicated.
6. Furnish joint fillers in one (1)-piece lengths. Where more than one (1) length is required, lace or clip joint- filler sections together.
7. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

B. Sealing of Expansion Joints: After the curing period, strip out all depth gauge strips and carefully clean expansion joints. Fill with joint compound as shown on Drawings. Avoid spilling compound on paved surfaces or overflowing from joint.

C. Contraction (Score) Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated on the Construction Drawings.

1. Tooled Contraction (Score) Joints:
   a. Form in fresh concrete using a jointer to cut the groove so that a smooth, uniform impression is obtained.
   b. Perform in a continuous operation to avoid misalignment of joints.
   c. Joint width and depth, see drawings.

3.06 PROTECTION AND CURING

A. Conform to all applicable requirements for curing and protection of concrete, Sections 90-7 and 90-8 of the Standard Specifications.

3.07 PROTECTION AND CURING

A. Protection:

1. Protect concrete against rapid drying and damage by rain [frost].
2. Keep concrete moist for at least 7 days. Protect with liquid curing compound, or a covering that will not stain or discolor finished concrete surfaces. Obtain acceptance of proposed method prior to use.

B. Spraying: Spray concrete during the curing period as frequently as drying conditions may require.

C. Curing: Cure concrete in accordance with the ACI Manual of Concrete Practice. During curing period, maintain concrete above 70 degrees F. for at least 3 days or above 50 degrees F. for at least 5 days.

D. Damage and Defacement: Protect all concrete work against damage and defacement during subsequent construction operations until final acceptance.

3.08 DAMP-PROOFING

A. Preparation of Surfaces:

1. Clean all surfaces to be dampproofed. Remove all dirt, grease, and other foreign matter which might interfere with adhesion and penetration. Allow surfaces to dry thoroughly.

3.09 FIELD QUALITY CONTROL

A. Samples: Owner will select a qualified testing laboratory to take samples for testing during the course of the work as considered necessary.

B. Cost of Testing: Paid for by the Contractor

C. Rejected Materials: Remove off the site all concrete below specified strength.

D. Cost of Removal and Retesting: Pay for full costs of removal of rejected concrete and its replacement with concrete of specified strength and retesting.

END OF SECTION

SECTION 04 2200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Concrete unit masonry work in place, complete.
2. Placement of reinforcing steel for masonry.
3. Incorporation of dowels, inserts, anchorage, and miscellaneous hardware in masonry.

B. Related Sections

1. Concrete foundations for masonry work: Section 03 3000.
2. Dowels and other anchors in concrete for anchoring masonry: Section 03 3000.
3. Furnishing and fabricating reinforcing steel: Section 03 3000.
4. Formwork and centering: Section 03 3000.
5. Anchors, hardware, similar items set in masonry: pertinent sections.

1.02 QUALITY ASSURANCE

A. Applicable Building Code: The California Building Code (CBC), latest version; CBC Standards as applicable, and ICC ES Evaluation Reports as referenced herein or as applicable.

B. Reference Standards: Latest official year of adoption or revision, unless otherwise specified herein.

1. American Society for Testing and Materials:

a.	ASTM C31	Making and Curing Concrete Test Specimens in the Field
b.	ASTM C39	Compressive Strength of Cylindrical Concrete Specimens.
c.	ASTM C40	Organic Impurities in Fine Aggregate for Concrete
d.	ASTM C90	Hollow, Load-Bearing Concrete Masonry Units
e.	ASTM C117	Test for Material Finer Than No. 200 Sieve in Mineral Aggregates by Washing
f.	ASTM C136	Sieve Analysis of Fine and Course Aggregates
g.	ASTM C144	Aggregate for Masonry Mortar
h.	ASTM C150	Portland Cement
i.	ASTM C207	Hydrated Lime for Masonry Purposes
j.	ASTM C404	Aggregate for Masonry Grout
k.	ASTM C426	Test for Drying Shrinkage of Concrete Block

1.03 TESTS AND INSPECTIONS (Including methods for determining compliance with designed strength of masonry). Methods described under A. or B. below may be used as directed or approved by the Structural Engineer.

A. Masonry Prism Testing Method: Conform to requirements of the latest version of CBC

Subsection 2105.2.2.2, consisting generally of the following:

1. Preliminary Prisms: Prior to commencement of construction, one set of 5 prisms shall be built using materials and workmanship to be used for the work. Prisms shall be tested at 28 days of age and shall exceed the F'm used in the design of the masonry. If desired, additional prisms may be built and tested at 3 days and 7 days of age to establish a relationship of 3-day, 7-day and 28-day test strengths. Prisms shall be built under the observation of the Structural Engineer and/or the masonry Inspector. Testing shall be done by the Laboratory of Record.
2. During Progress of the Work: When full allowable stresses are used in the work, 1 set of 3 prisms shall be built and tested for every 5,000 square feet of wall or fraction thereof. These prisms shall meet or exceed the values obtained with the preliminary prism tests.
3. If one-half of the allowable stresses are used in design, testing during construction is not required provided that the supplier of materials submits certification that they are consistent with the materials used for the Preliminary Prisms.
4. (Option) - Masonry Prism Test Record: Compressive strength verification shall comply with the latest version of CBC Subsection 2105.2.2.2. Requires submittal of at least 30 tests, built and tested in accordance with ASTM C1314 under observation by an Engineer or Special Inspector and tested by an approved Testing Agency. The Record shall be acceptable to the Building Official and the Structural Engineer, and the average compressive strength of the Test Record shall equal or exceed 1.33 F'm.

B. Unit Strengths of Masonry Components Method: Conform to requirements of the latest version of CBC Subsection 2105.2.2.1, including masonry Units, Mortar, and Grout as follows:

1. Concrete Masonry Units: Shall be sampled from units delivered to job and tested for characteristics required by ASTM C90 and additionally tested for linear shrinkage, not to exceed 0.05 percent. If acceptable to the Structural Engineer and the Building Official, producer may submit recent test reports (1 month) representative of units to be used in this work. CNCMA Q-Block Tests, most recent quarter, are also acceptable. Preliminary Prism Tests described in Par. A.1. above also meet this requirement.
2. Portland Cement: Shall be mill tested. Furnish certificates of compliance with each shipment. If requested by the Structural Engineer, mill test reports shall be submitted.
3. Hydrated Lime: Certificates of Compliance from the producer shall be submitted for review.
4. Mortar and Grout Aggregates: Test for compliance with standards specified for each type of material and the following:
    a. Sieve Analysis: ASTM C136.
    b. Organic Impurities: ASTM C40.
    c. Material finer than No. 200 sieve: ASTM C117.
5. Test Samples - Mortar: Conform to the latest version of the CBC,

    Chapter 21.

    a. One pair of samples made by Masonry Inspector from each day of masonry work in standard 2 x 4 inch waxed paper cylinders provided by Laboratory. Spread 1/2 to 5/8 inch of mortar on masonry units to be used

in the construction and allow to stand for one (1) minute. Remove and pack uniformly in cylinder in two (2) layers. Allow to set for 48-hours before Laboratory removes molds.

b. Cure and test in accordance with ASTM C39.

c. Samples shall exhibit the following strengths:

(1) after 7 days - 1200 psi, minimum

(2) after 28 days - 2000 psi, minimum

6. Test Samples - Grout: Conform to the latest version of CBC, Chapters 19 and 21.

a. One pair of samples made by Masonry Inspector from each day of grouting. Make samples in molds approximately 3 x 3 x 6 inches high, made from masonry units to be used in the construction. Line mold with soft, absorbent paper towels, do not use wax paper or plastic wrap. Place grout as taken from the mixer and puddle with a wooden stick in a manner similar to the actual work. Allow to set for 48-hours before Laboratory removes molds.

b. Cure and test in manner specified for concrete cylinders.

c. Samples shall exhibit following strengths:

(1) after 7 days - 1200 psi, minimum.

(2) after 28 days - 2000 psi, minimum.

7. Core Tests or Prism Tests, cut from completed walls: Required only upon request of Engineer on basis of non-conforming test results or deficient workmanship. Location and frequency as directed by Engineer.

C. Inspections:

1. Provide continuous inspection by a qualified Masonry Inspector of all laying and grouting of masonry work.

OR

1. Continuous inspection of masonry work when half stresses are used in design is not required. Provide limited inspection concurrent with required sampling of mortar and grout.

2. Batch Plant Inspection - Grout: If batch plant is approved and complies with requirements of the latest version of the CBC, continuous batch plant inspection shall be waived if the producer furnishes Bonded Private Deputy Weighmaster affidavits covering all grout furnished and Weighmaster signs all load tickets. Batch plant inspection shall be provided for the first load and only when requested by Engineer thereafter.

D. Mix Designs - Grout: For grout furnished as ready-mix, Laboratory shall furnish grout mix design with actual batch-weights conforming to specified proportions.

E. For dry, bagged, pre-mixed mortar and grout, submit producer's reports of tests.

1.04 SUBMITTALS

A. Samples of concrete masonry units to be used for work, including specimens of cut block to be used for veneered portions, as a basis for comparing materials actually used in work. Masonry used on project shall match accepted samples.

B. Required Certificates of Compliance, Identity or Quality.

C. Submit manufacturers' printed data and specifications for all accessory materials.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store materials at site such that easy access for proper inspection and identification of each shipment is permitted.

B. Separate material of each shipment for size and shape in a manner approved by Engineer.

C. Store all materials off the ground, under cover and away from damp surfaces.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete Masonry Units.

1. Manufacturers.

a. Angelus Block Co., Inc.

b. Orco Block Co., Inc.

c. Basalite Concrete Products.

d. Calstone Company.

e. Or equal.

2. At Above-Grade Site Mechanical Enclosures: Load bearing, medium weight concrete masonry units conforming to ASTM C90.

a. Concrete masonry units shall be from the same production run.

b. Angelus Block “Harvest” or Orco “Wheat” color, split face 1-side units 12 x 8 x 16 inches. Use split face 1-side 1-end units at corners.

c. Minimum compression strength is 2000 psi.

d. All cells shall be fully grouted.

B. Water: Use water from domestic source that is clean and free from odor and harmful amounts of acids, alkalis, organic or other deleterious chemicals.

C. Mortar Sand: Washed, natural sand conforming to ASTM C144.

D. Grout Sand: Washed, natural grout sand conforming to ASTM C404, Size No. 1.

E. Pea Gravel: Clean, natural 3/8" aggregate conforming to ASTM C403, Size No. 8.

F. Portland Cement: Conform to ASTM C150, Type II, low alkali.

G. Hydrated Lime: Conform to ASTM C207, Type S.

H. Dry, bagged, pre-mixed mortar and grout mixes covered by an ICC-ES Evaluation Report are acceptable.

I. Admixture - Grout: "Grout-Aid" by Sika Chemical Co. - use in accordance with manufacturer's written instructions. Add at job site.

2.02 MORTAR AND GROUT MIXES

A. Mortar: Type S, per the latest version of CBC 2103.9.

B. Grout: Per the latest version of CBC 2103.13.

C. Job Mixing: By accurate, dry volume measurement in mechanical mixer. Grout may be furnished as ready-mixed. Handmixing is not allowed.

1. Mixing: Mix short water, cement and aggregate for two (2) minutes. Add lime and remaining water and mix for at least ten (10) minutes. Adjust water for proper slump.

D. Retempering: On mortar board in basin formed in mortar, water worked in. Grout or mortar that is non-plastic or more than one (1) hour old shall not be used.

E. Ready-Mix Grout: Grout batched off-site and delivered by truck mixer shall be accompanied by load tickets signed by licensed Weighmaster.

PART 3 - EXECUTION

3.01 PLACING REINFORCEMENT

A. Low-Lift Grouting: Place vertical bars in conformance with the Drawings prior to starting masonry work. Vertical bars shall be tied to both the foundation dowels and the horizontal bars at maximum 4'-0" intervals above the foundation and braced at the top of the bars. Horizontal bars shall be laid in place as the work progresses.

B. High-Lift Grouting: After the lift is completed but before grouting, place vertical bars through standard bright steel wire centering devices laid in bed joints at 4'-0" intervals above the foundation, making sure entire lift is reinforced, tie to foundation dowels. Horizontal bars shall be placed as work progresses.

C. Dowels: Provide dowel of same size for each vertical and horizontal bar required to be anchored to adjoining construction.

D. Encasement: Reinforcing steel shall be fully encased in grout and mortar with at least 1/2 inch between any bar and masonry surface.

E. Splices: Lap full 40 bar diameters or 24 inch minimum, whichever is greater, at wall intersections and around corners. Refer to drawings.

F. Corners: Provide at least one #5 bar at each corner and intersection unless detailed otherwise. Refer to drawings.

3.02 LAYING CONCRETE MASONRY UNITS

A. Foundation Preparation: Sandblast tops of supporting concrete elements prior to commencing masonry work to ensure good bonding surfaces. Hose off concrete surfaces with high pressure water through a nozzle.

B. Lay masonry units dry. Saw-cut units accurately where cutting is required. Lay-up walls plumb, coursing level and true to face surfaces. Use bond beam units inverted at base course and at all horizontal bars.

C. Tolerances - Deviations shall not exceed:

1. Joint thickness: 1/8"+/-.

2. Variations of face plane between adjacent units: 1/8"+/-, non cumulative.

3. Level (coursing): ¼" in 10 feet, non-cumulative.

4. Plumb: 3/16" in 4 feet, non-cumulative.

D. Bond Pattern and Joints: Lay masonry units in common running bond with uniform 3/8 inch mortar joints. Butter head joints the thickness of face shell and shove block into place. Block required to be reset shall be removed, cleaned of mortar and layed in fresh mortar. Strike mortar flush on insides of cells to permit grouting.

E. All exposed joints shall be tooled to a dense, shallow cove joint. Non-exposed joints may be trowel-struck flush.

3.03 GROUTING MASONRY

A. All cores shall be grouted solid.

B. Method of Grouting:

1. Low-Lift Grouted Construction

a. Units shall be laid a maximum of 4 feet before grouting all cells. All overhanging mortar and mortar droppings shall be removed. Conform to the latest version of Sections 2104A.5.1.1.1.1 and 2104A5.1.2.1.1, California Building Code.

b. Grouting shall follow each 4 feet high lift of construction laid and shall be consolidated so as to completely fill all voids and embed all reinforcing steel. Provide cleanouts for pours over 5 feet in height.

c. When grouting is stopped for one hour or longer, horizontal construction joints shall be formed by stopping the pour of grout not less than ½ inch nor more than 2 inch below the top of uppermost unit grouted.

d. Horizontal steel shall be fully embedded in grout in an uninterrupted pour.

2. High-Lift Grouted Construction

a. Where high lift grouting is used, conform to the latest version of Sections 2104A.5.1.1.1.2 and 2104A5.1.2.1.2, California Building Code. Maximum height of pour, 4 feet.

b. Cleanout openings shall be provided at the bottom of each pour of grout. Any overhanging mortar of other debris shall be removed from the insides of cell walls.

c. The foundation or other horizontal construction joints shall be cleaned of all loose material and mortar droppings before each pour.

d. Seal cleanouts before grouting. All cells shall be filled.

e. Approved admixture that reduces early water loss and produces and expansive action shall be used in the grout.

3.04 CURING, PROTECTION AND CLEANING

A. Curing: Protect exposed exterior surfaces from hot sun and extreme heat by covering with burlap or kraft paper.

3.05 FORMS, SHORING AND CENTERING

A. Forms, shoring and centering for masonry shall be substantial. Centering for openings shall remain in place for at least 14 days.

3.06 HARDWARE, ANCHORAGE AND INSERTS

A. Install where and how required. Contractor is responsible for proper location.

B. Anchor bolts or other anchors embedded in masonry are to be covered with a minimum thickness of one (1) inch of grout on all sides and surfaces for the entire embedded length of each bolt or anchor.

3. 07 PROTECTION OF MASONRY FROM RAIN DAMAGE

A. During rainy weather, or if rain is anticipated, the tops of uncompleted masonry walls shall be protected from water saturation by covering with waterproof covers that are weighted or otherwise held in-place.

3.08 DEFECTIVE MASONRY

A. All masonry shall be plumb, level, true to line, surface and grade to the best standards of the trade. Masonry work which is not plumb and level or which contains defects shall be repaired or replaced to the satisfaction of Engineer at no cost to Owner.

B. Replacement of defective masonry by Contractor shall include all expense of additional testing and inspections required as a result of such defective masonry. Repair of holes from core or prism cutting is included in these provisions.

END OF SECTION

SECTION 05 0525 – POST-INSTALLED CONCRETE ANCHORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Post-installed mechanical anchors in concrete, including:

   a. Wedge-type expansion anchors approved for use for seismic applications in cracked and uncracked concrete.

   b. Screw-type drilled-in anchors approved for use for seismic applications in cracked and uncracked concrete.

2. Post-installed adhesive anchors in concrete, approved for use for seismic applications in cracked and uncracked concrete.

1.02 REFERENCES

A. ICC-ES or IAPMO-ES Evaluation Report: Evaluation Report issued by the ICC or IAPMO Evaluation Service demonstrating compliance with provisions of the 2009 International Building Code.

1.03 DEFINITIONS

A. Nominal Embedment Depth: Minimum length from concrete surface to end of anchor following completion of anchor installation. For wedge-type anchors, nominal embedment depth shall be measured following application of installation torque.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01, "Submittal Procedures".

1. Manufacturer's product data.

2. Manufacturer’s installation instructions.

3. ICC-ES or IAPMO-ES Evaluation Reports.

1.05 QUALITY ASSURANCE

A. Certifications: Anchors shall have an active ICC-ES or IAMPMO-ES Evaluation Report in accordance with the following ICC-ES Acceptance Criteria:

1. Mechanical Anchors in Concrete: Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC 193).

2. Adhesive Anchors in Concrete: Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC 308).

PART 2 - PRODUCTS

2.01 MECHANICAL ANCHORS

A. General: Anchors shall be tested and approved for use in cracked and uncracked concrete in accordance with ICC-ES AC 193.

1. Anchors installed through underside of steel deck shall be tested and approved for installation through the soffit of concrete-filled metal deck assemblies in accordance with ICC-ES AC 193.

B. Acceptable Products: Where anchor manufacturer and product are indicated on Drawings, provide designated product.

1. Contractor shall be allowed to substitute products of other manufacturer's, subject to demonstrating equivalent tension and shear strength to specified anchor, under project installation conditions.

2. Where anchor design is prepared by Trade Subcontractor's Engineer, use product designated by Trade Subcontractor's Engineer, subject to meeting requirements of this Section.

C. Wedge Anchors: Wedge type, torque-controlled expansion anchors. Size and nominal embedment depth as indicated on Drawings.

1. Material: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, SC1, Type III. As indicated on the Drawings, provide AISI Type 304 or Type 316 stainless steel anchors with manufacturers matching nut and washer.

2. Acceptable Products: Where anchor product and manufacturer are not indicated on Drawings or designated by Trade Subcontractor's Engineer, provide one of the following:

a. Kwik Bolt TZ, by Hilti, Inc.

b. Strong-bolt 2, by Simpson Strong-Tie Co. Inc.

c. Power-Stud+ SD2, by Powers Fasteners, Inc.

d. Trubolt+ Wedge Anchor, by ITW Red Head.

D. Screw Anchors: Hardened steel, screw-type anchors or rod hangers approved for use in cracked and uncracked concrete. Diameter and nominal embedment depth as indicated on Drawings.

1. Limitations: Anchors shall be used in dry interior environments only.

2. Material: Case hardened low carbon steel, with zinc plating in accordance with ASTM B633, SC1, Type III.

3. Acceptable Products: Where anchor product and manufacturer are not indicated on Drawings or designated by Trade Subcontractor's Engineer, provide one of the following:

a. Kwik HUS-EZ screw anchor and HUS-EZ1 rod hanger, by Hilti.

b. Titen HD Screw Anchor and Titen HD Rod Hanger, by Simpson Strong-Tie Co. Inc.

c. Wedge-Bolt+ and Vertigo+ Rod Hanger, by Powers Fasteners.

2.02 ADHESIVE ANCHORS

A. Adhesive Anchors: Threaded steel rod or inserts complete with nuts and washers, epoxy adhesive injection system, and manufacturer's installation instructions.

B. General: Anchors shall be tested and approved for use to resist seismic forces (IBC Seismic Design Categories A to F) in cracked and uncracked concrete in accordance with ICC-ES AC 308.

C. Epoxy Adhesive: Two-component, 100% solids, structural epoxy conforming to ASTM C881, Type IV; Grade 3; prepackaged in cartridges for manually or pneumatically operated caulk gun and automatically mixed at nozzle.

1. Where anchor manufacturer and product are indicated on Drawings, provide designated product.

2. Contractor shall be allowed to substitute products of other manufacturer's, subject to demonstrating equivalent tension and shear strength to specified anchor, under project installation conditions.

3. Where anchor design is prepared by Trade Subcontractor's Engineer, use product designated by Trade Subcontractor's Engineer, subject to meeting requirements of this Section.

4. Acceptable Products: Where anchor product and manufacturer are not indicated on Drawings or designated by Trade Subcontractor's Engineer, provide one of the following:

a. HIT RE500 V3 Epoxy Adhesive Anchoring System, by Hilti, Inc.

b. Set-XP Epoxy Adhesive, by Simpson Strong-Tie Co. Inc.

c. PE 1000+, by Powers Fasteners, Inc.

d. Epcon G5 adhesive, by ITW Red Head.

D. Threaded Rod:

1. Material: Unless otherwise indicated on the Drawings, furnish carbon steel threaded rods conforming to ASTM A36 or ASTM A193 Type B7. As indicated on the Drawings, provide Type 304 or Type 316 stainless steel anchors with manufacturers matching nut and washer.

2. Finish: Furnish carbon steel rods with zinc plating in accordance with ASTM B633, SC1, Type III at dry interior locations. Furnish carbon steel rods with hot-dipped galvanized coating complying with ASTM A153 at exterior and damp interior locations.

END OF SECTION

SECTION 05 1200 - STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes structural steel framing members, support members, suspension cables, sag rods, struts; base or bearing plates, shear stud connectors and expansion joint plates; anchor bolts for structural steel; beams, girders, purlins, and girts; bearing of steel for girders, trusses or bridges; bracing; columns, posts; connecting materials for framing structural steel to structural steel; crane rails, splices, stops, bolts, and clamps; door frames constituting part of the structural steel frame; expansion joints connected to the structural steel frame; fasteners for connecting structural steel items; permanent shop bolts; shop bolts for shipment; field bolts for permanent connections; permanent pins; floor plates (checkered or plain) attached to the structural steel frame; grillage beams and girders; hangers essential to the structural steel frame; leveling plates, wedges, shims, and leveling screws; lintels, if attached to the structural steel frame; trusses; and grouting under base plates.

B. Related Sections:

1. Section 01 4523: Testing and Inspection

1.02 REFERENCES

A. AISC (American Institute of Steel Construction) - Load and Resistance Factor (LRFD) Specification for Structural Steel Buildings.

B. AISC (American Institute of Steel Construction) - Specification for Structural Steel Buildings, Allowable Stress Design (ASD).

C. AISC (American Institute of Steel Construction) - Code of Standard Practice for Structural Steel Buildings and Bridges.

D. AISC (American Institute of Steel Construction) - Seismic Provisions for Structural Steel Buildings.

E. ASTM A36/A36M - Carbon Structural Steel.

F. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

G. ASTM A123 - Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.

H. ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.

I. ASTM A242/A242M - High-Strength Low-Alloy Structural Steel.

J. ASTM A307 - Carbon Steel Bolts and Studs, 60 ksi Tensile Strength.

K. ASTM A325 - Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.

L. ASTM A449 - Tempered Steel Bolts and Studs.

M. ASTM A490 - Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.

N. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

O. ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

P. ASTM A514/A514M - High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.

Q. ASTM A529/A529M - High-Strength Carbon-Manganese Steel of Structural Quality.

R. ASTM A563 - Carbon and Alloy Steel Nuts.

S. ASTM A568/A568M - Steel, Sheet, Carbon and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled Sheet, General Requirements for.

T. ASTM A572/A572M - High-Strength, Low-Alloy Columbium-Vanadium Structural Steel.

U. AWS A2.4 (American Welding Society) - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

V. AWS D1.1 (American Welding Society) - Structural Welding Code - Steel.

W. FM (Factory Mutual) - Roof Assembly Classifications.

X. RCSC (Research Council on Structural Connections) - Specification for Structural Joints Using ASTM A325 or A490 Bolts, LRFD or ASD.

Y. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual, Volumes 1 and 2.

Z. UL (Underwriters Laboratory, Inc.) - Fire Resistance Directory.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Shop Drawings, Product Data and Samples.

1. Materials Identification Report: A report of material identification, together with identified copies of the mill test reports, shall be submitted to the Structural Review Board selected by the University by the Testing Laboratory when manufacturer's mill test reports are used to establish conformity with material specifications.

2. Shop and Erection Drawings: Submit checked prints of shop and erection drawings for structural steel work.

3. Record Set of Drawings: After structural steel has been erected and approved shop and erection drawings have been corrected to correspond with changes made in field, submit a complete corrected set of prints.

1.04 QUALITY ASSURANCE

A. Structural steel shall conform to Title 24, as indicated in Section 01 45 23, except that steel manufactured by acid Bessemer process shall not be used for structural purposes.

B. Structural steel used in welded construction shall have the properties suitable for welding.

C. Structural steel shall conform to "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings."

1.05 REGULATORY REQUIREMENTS

A. Perform Work in accordance with Chapter 22, "Steel," of the California Building Code, Title 24, Part 2.

B. Sheet and strip steels and steels other than those listed in the latest version of CBC, Title 24, C.C.R., if used for structural purpose, shall be specifically approved by the Project Engineer-of-Record.

1.06 PRODUCT HANDLING

A. Store structural steel above ground on platforms, skids or other approved supports.

B. Protect steel from corrosion.

C. Store welding electrodes in accordance with AWS D 12.1.

D. Store other materials in a weathertight and dry place, until ready for incorporation into work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Stock Materials: Provide exact materials, sections, shapes, thickness, sizes, weights and details of construction indicated on Drawings. Changes because of material stock or shop practices will be considered for approval if net area of shape or section is not reduced thereby, if material and structural properties at least equivalent, and if overall dimensions are not exceeded.

B. All steel exposed to the exterior environment shall be galvanized and painted.

C. All steel exposed to view in interior spaces shall be painted.

2.02 MATERIALS

A. Structural Steel: Structural steel beams and columns shall conform to ASTM A-992 Grade 50; steel plates to ASTM A-572 A36.

B. Steel Pipe: ASTM A53 - Type E or S, grade B.

C. Structural Tubing:

1. Hot-formed, ASTM A500, grade 2.

2. Cold-formed, ASTM A500, grade B.

D. Bar Stock for Anchor Bolts: ASTM A36.

E. Machine Bolts and Nuts: ASTM A307, grade A.

F. High Strength Steel Bolts: Latest version of CBC Chapter 22, "Steel" for high strength bolts.

G. Plain Washers: ANSI B27.2.

H. Galvanizing: ASTM A123.

I. Primer: "Tnemec V10" or equal.

2.03 FABRICATION

A. Cleaning and Straightening Materials: All materials being fabricated shall be thoroughly cleaned of all scale and rust, and straightened before being worked on. Cleaning and straightening methods shall not injure material. After punching or working component parts of a member, all twists or bends shall be removed before parts are assembled.

B. Fabricate work in accordance with the latest version of CBC Chapter 22, "Steel."

C. Cutting, Punching, Drilling and Tapping: Unless otherwise indicated or specified, structural steel fabricator shall do all cutting, punching, drilling and tapping of his work so that work of other trades will properly connect to steel work.

D. Milling: Compression joints depending on contact bearing shall have bearing surfaces prepared to a common plane by milling.

E. Use of Burning Torch: Oxygen cutting of members shall be done by machine. Gouges greater than 3/16" that remain from cutting shall be removed by grinding. All reentrant corners shall be shaped notch free to a radius of at least 1/2". Gas cutting of holes for

bolts or rivets is prohibited.

F. Galvanizing: After fabrication, items indicated or specified to be galvanized shall be hot-dipped galvanized in largest practical sizes. "Fabrication" includes all operations of shearing, punching, bending, forming, assembling or welding. Galvanized items shall be free from projections, barbs or icicles resulting from galvanizing process. Galvanizer shall optimize galvanized coating for painted finish.

G. Welding:

1. Type of steel used in welded structures shall have chemical properties suitable for welding as determined by chemical analysis. Welds shall conform to the requirements of Title 24, as indicated in Section 01 45 23.

2. Materials and workmanship shall conform to the requirements specified herein and per the latest version of CBC Chapter 22, "Steel," modified as follows:

   a. No welded splices shall be made except those indicated on Drawings unless approved in writing by the University Representative.

   b. Drawings will designate joints in which it is important that welding sequence and technique be controlled to minimize shrinkage stresses and distortion.

3. Welding shall be performed in accordance with requirements of the "American Welding Society" (AWS) and "Structural Welding Code."

H. Shop Finish:

1. Notify the University Representative when work is ready to receive shop prime coat. Work shall be inspected and approved by the University Representative before application of primer.

2. Structural steel and fittings, except galvanized items, which will be exposed when building is completed shall receive a coat of primer.

3. The primer specified shall be spray applied, filling all joints and corners and covering all surfaces with a smooth unbroken film. The minimum dry film thickness of the primer shall be 2.0 mils. Follow manufacturer's instructions for thinning.

2.04 QUALITY CONTROL

A. Tests:

1. Structural steel shall be identified in accordance with Title 24, Part 2, as indicated in Section 01 45 23, the grade and ASTM specification number or designation shall be indicated on each lift or bundle of fabricated elements.

2. If structural steel cannot be identified at least one tension and elongation test and one bend flattening test shall be made for each piece.

3. For castings and forgings, chemical analysis and one tension and elongation test will be required for each heat. Complete four-sided inspection shall be made of all castings.

4. For sheet and strip steel, one tension and elongation test and one bend or flattening test for each 5 tons or fractional part thereof for each size or gage will be required.

5. Test specimens shall be furnished by steel fabricator and taken under direction of the Testing Laboratory to dimensions required by "Standard Methods and Definitions for Mechanical Testing of Steel Products," ASTM A370.

6. Cost of tests of stock will be borne by the University, except that if a test fails to

comply with requirements of Specifications, cost of testing shall be borne by Contractor.

7. If after fabrication and inspection, work is found to be defective and requires re-inspection, costs of such re-inspection shall be borne by Contractor.

8. Steel fabricator shall provide all labor, equipment and facilities necessary for moving and handling materials to be inspected.

B. Welding Inspections:

1. Inspection of all shop and field welding operations shall be made by a qualified American Welding Society (AWS) Certified Welding Inspector approved by the University. The welding inspector shall make a systematic record of all welds (see Section 01 45 23) including:

a. Identification marks of welders.

b. List of defective welds.

c. Manner of correction of defects.

2. The Welding Inspector shall be notified at least 2 days before shop or field welding inspection is to be required.

3. The Welding Inspector shall check the material, equipment and procedures, as well as welds and competence of welder. He shall furnish a report that welding which is required to be inspected is proper and has been done in conformity with approved Drawings and Specifications.

4. The Welding Inspector shall use all means necessary to determine quality of weld and may use gamma ray, magnaflux, trepanning sonics or any other aid to visual inspection deemed necessary to assure adequacy of welding.

C. Inspection of Shop Fabrication: Shall be in accordance with Title 24, indicated in Section 01 45 23.

D. Inspection of High Strength Bolt Installation: Shall be in accordance with Title 24, indicated in Section 01 45 23.

E. Tests of End Welded Studs: End welded studs shall be tested in accordance with Title 24, indicated in Section 01 45 23.

PART 3 - EXECUTION

3.01 VERIFICATION

A. Verify governing dimensions and conditions at job site before commencing erection work.

3.02 ERECTION

A. Erect all steel in strict accordance with Drawings, approved shop drawings and all standards.

B. Where indicated for field connections, standard bolts (ASTM A307), do not require washers under head or under nut, except that beveled washers are required when outer face of the bolted parts have a slope greater than 5%.

C. Install high strength steel bolts at locations indicated. Assembly and installation shall be in accordance with the latest version of CBC Chapter 22A, "Steel" for high strength bolts.

D. Erect structural steel plumb and level and to proper tolerances as set forth in the AISC Manual. Provide all temporary bracing, supports or connections required for complete safety of structure until final permanent connections are made.

E. Set column bases within a tolerance of 1/8" of detailed center lines, and set and level at proper elevations. Support bases on double nuts and solidly fill all spaces under bases with drypack cement grout rammed into place.

3.03 FINISHING

A. After erection, spots or surfaces where paint has been removed, damaged, or burned off and field rivets, bolts, and other field connections not concealed in work, shall be cleaned of dirt, oil, grease, and burned paint and given a spot coat of same primer used for shop priming.

B. Damaged galvanized surfaces shall be coated with Galvalloy, Galvabar or equal. Heat damaged surface to approximately 600 degrees Fahrenheit. Rub alloy bar over heated surface. Paint is not acceptable.

C. Prepare and paint galvanized and ungalvanized steel as specified in project specification Division 09.

END OF SECTION

SECTION 07 8400 – FIRESTOPPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of all joints and penetrations in fire resistance rated and smoke resistant assemblies, whether indicated on drawings or not, and other openings indicated.

C. Provide firestopping in conjunction with work specified in the following Divisions:

1. Division 22: Holes or voids created to extended fire suppression and supervisory systems through fire-rated roofs, floors, and walls

2. Division 23: Holes or voids created to extend mechanical systems through fire-rated roofs, floors, and walls.

3. Division 26: Holes or voids created to extend electrical systems through fire-rated roofs, floors, and walls.

1.02 RELATED REQUIREMENTS

A. Section 22 0000 – Common Work Results for Plumbing

B. Section 23 0500 – Common Work Results for HVAC

C. Section 23 2300 – Refrigerant Piping

D. Section 26 0534 – Conduit

1.03 REFERENCES

A. ASTM E814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

B. UL (DIR) – Online Certifications Directory; current listings at database.ul.com.

C. UL (FRD) – Fire Resistance Directory; current edition.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide data on product characteristics, performance ratings, and limitations.

C. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.01 FIRESTOPPING - GENERAL REQUIREMENTS

A. Manufacturers:

1. A/D Fire Protection Systems Inc.

2. 3M Fire Protection Products.

3. Hilti, Inc.

4. Nelson FireStop Products.

B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.03 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

A. Penetrations Through Walls By:

B. Uninsulated Metallic Pipe, Conduit, and Tubing:

C. 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2.04 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

A. Penetrations By:

1. Uninsulated Metallic Pipe, Conduit, and Tubing:

a. 1 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:

a. 1 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2.05 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements.

B. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less: Caulk or putty.

C. Firestopping at Combustible Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

3.04 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 08 7100 – DOOR HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding doors.
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Automatic operators.
4. Cylinders specified for doors in other sections.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. UL/ULC and CSA C22.2 – Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors. State Building Codes, Local Amendments.

D. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.03 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.

b. Manufacturer of each item.

c. Fastenings and other pertinent information.

d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.

e. Explanation of abbreviations, symbols, and codes contained in schedule.

f. Mounting locations for door hardware.

g. Door and frame sizes and materials.

h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.

b. Complete (risers, point-to-point) access control system block wiring diagrams.

c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

G. All submittal items shall be reviewed by University Lock Shop.

1.04 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.

2. Plans for existing and future key system expansion.

3. Requirements for key control storage and software.

4. Installation of permanent keys, cylinder cores and software.

5. Address and requirements for delivery of keys.

G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.06 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.07 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Five years for exit hardware.
3. Twenty five years for manual surface door closer bodies.
4. Five years for motorized electric latch retraction exit devices.
5. two years for electromechanical door hardware.

1.08 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.02 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:
   a. Two Hinges: For doors with heights up to 60 inches.
   b. Three Hinges: For doors with heights 61 to 90 inches.
   c. Four Hinges: For doors with heights 91 to 120 inches.

d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.

b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.

b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out- swinging lockable doors.

5. Manufacturers:

a. Hager Companies (HA) - BB Series.

b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - TA Series.

B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Hager Companies (HA).

b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

C. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 certified pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed teflon coated stainless pin, and twin self-lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).

b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.03 POWER TRANSFER DEVICES

A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. Securitron (SU) - EL-CEPT Series.

B. Concealed Quick Connect Electric Data Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified access control door hardware. Furnish with Molex™ or RJ-45 standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. Securitron (SU) - CEPT-C5E Series.

C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through- door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Manufacturers:

a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC- C Series.

b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – PoE Series.

2.04 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.

2. Furnish dust proof strikes for bottom bolts.

3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.

4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

b. Trimco (TC).

B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

1. Manufacturers:

a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

b. Trimco (TC).

C. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
5. Manufacturers:
   a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
   b. Trimco (TC).

2.05 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

C. Cylinders: Original manufacturer cylinders complying with the following:
1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
5. Keyway: Match Facility Restricted Keyway.

D. Patented Cylinders: ANSI/BHMA A156.5, Grade 1, certified cylinders employing a utility patented and restricted keyway requiring the use of patented controlled keys. Provide bump resistant, fixed core cylinders as standard with solid recessed cylinder collars. Cylinders are to be factory keyed where permanent keying records will be established and maintained.
1. Provide a 6 pin multi-level master key system comprised of patented controlled keys and security and high security cylinders operated by one (1) key of the highest level. Geographical exclusivity to be provided for all security and high security cylinders and UL437 certification where specified.
   a. Level 1 Cylinders: Provide utility patented controlled keyway cylinders that are furnished with patented keys available only from authorized distribution.
2. Manufacturers:
   a. Corbin Russwin (RU) – Access 3 Series.

E. Keying System: Each type of lock and cylinders to be factory keyed.
1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.

2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.

3. New System: Key locks to a new key system as directed by the Owner.

F. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)

2. Master Keys (per Master Key Level/Group): Five (5).

3. Construction Keys (where required): Ten (10).

G. Construction Keying: Provide construction master keyed cylinders.

2.06 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:

a. Corbin Russwin Hardware (RU) – ML2000 Series.

2.07 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.

2. Strikes for Bored Locks and Latches: BHMA A156.2.

3. Strikes for Auxiliary Deadlocks: BHMA A156.36.

4. Dustproof Strikes: BHMA A156.16.

2.08 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with

the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

5. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.

6. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.

7. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.

8. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

   a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.

   b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

9. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

10. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.

11. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

12. Extended cycle test: Devices to have been cycle tested in ordinance with ANSI/BHMA 156.3 requirements to 50 million cycles.

13. Rail Sizing: Provide exit device rails factory sized for proper door width application.

14. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:

   a. Sargent Manufacturing (SA) - 80 Series.

2.09 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Manufacturers:
   a. LCN Closers (LC) - 4040XP Series.
   b. Norton Door Controls (NO) – 9500 Series.

2.10 ELECTROHYDRAULIC DOOR OPERATORS

A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.

1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.

B. Standard: Certified ANSI/BHMA A156.19.

C. Performance Requirements:

1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.

D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.

E. Certification: Furnish Operators with GreenCircle Certification.

F. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.

G. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.

H. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.

I. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.

J. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. LCN Closers (LC) - 4640 Series.
2. Norton Door Controls (NO) - 6000 Series.

2.11 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
    a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
    a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    b. Trimco (TC).

2.12 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated,

unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:
    a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    b. Trimco (TC).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:
    a. Rixson Door Controls (RF).
    b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.13 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. National Guard Products (NG).
2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.14 ELECTRONIC ACCESSORIES

A. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Manufacturers:

   a. Corbin Russwin Hardware (RU) - BPS Series.

   b. Securitron (SU) - BPS Series.

B. Energy Efficient Switching Power Supplies: Provide UL listed or recognized filtered and regulated power supplies. Provide single voltage units as shown in the hardware sets. Units must have one access control input and one fire alarm input. Standby power consumption of unit must be less than 10mW at 120VAC. Provide integral battery backup as standard for all units. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Manufacturers:

   a. Securitron (SU) – EPS Series.

2.15 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.16 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.02 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series. B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.03 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."

4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.04 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.05 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.06 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.07 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.08 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.

C. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. MR - Markar
4. RO - Rockwood
5. SA - SARGENT
6. RU - Corbin Russwin
7. HS - HES
8. RF - Rixson
9. NO - Norton
10. SU - Securitron

END OF SECTION

SECTION 09 9113 – EXTERIOR PAINTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish exterior surfaces unless fully factory-finished and unless otherwise indicated.

1.02 RELATED REQUIREMENTS

A. Section 13 3400 – Fabricated Engineered Structure for Interior Paint

B. Section 23 0553 - Identification for HVAC Piping and Equipment: Painted identification.

C. Section 26 0553 - Identification for Electrical Systems: Painted identification.

1.03 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2016.

C. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2005 (Reapproved 2012).

D. ASTM D4259 - Standard Practice for Abrading Concrete; 1988 (Reapproved 2012).

E. ASTM D4260 - Standard Practice for Liquid and Gelled Acid Etching of Concrete; 2005 (Reapproved 2012).

F. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2015.

G. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board; 2007.

H. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; current edition, www.paintinfo.com.

I. SCAQMD 1113 - South Coast Air Quality Management District Rule No.1113; current edition.

J. SSPC V1 (PM1) - Good Painting Practice: Painting Manual, Volume 1; Fourth Edition.

K. SSPC V2 (PM2) - Systems and Specifications: Steel Structures Painting Manual, Volume 2; Fourth Edition.

L. SSPC-SP 1 - Solvent Cleaning; 2015.

M. SSPC-SP 2 - Hand Tool Cleaning; 1982 (Ed. 2004).

N. SSPC-SP 3 - Power Tool Cleaning; 1982 (Ed. 2004).

O. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

P. SSPC-SP 13 - Surface Preparation of Concrete; (Reaffirmed 2015); 2003.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide complete list of products to be used, with the following information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
2. MPI product number (e.g. MPI #47).
3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
4. Manufacturer's installation instructions.

C. Submit two paper chip samples for exterior paint color.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum six years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Minimum Application Temperatures for Latex Paints: 50 degrees F (10 degrees C) for exterior; unless required otherwise by manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Paints:

1. Behr Process Corporation.
2. Pratt & Lambert Paints.
3. Sherwin-Williams Company.
4. Dunn Edwards.

2.02 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready mixed, unless required to be a field-catalyzed paint.

1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
2. Supply each paint material in quantity required to complete entire project's work from a single production run.
3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

2.03 PAINT SYSTEMS – EXTERIOR

A. Exterior surfaces to be primed and painted, unless otherwise indicated. Submit exterior color samples to Owner for review and approval. The building exterior shall be green.

B. Do Not Paint or Finish the Following Items:

1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
2. Concrete and concrete masonry brick.
3. Galvanized Unistrut.
4. Items indicated to remain unfinished.
5. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not begin application of paints and finishes until substrates have been properly prepared.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

F. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

A. Apply products in accordance with manufacturer's written instructions.

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance.

D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

SECTION 09 9173 – STEEL COATINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 DESCRIPTION

A. This Section describes the requirements for furnishing and applying special coatings on the following:

1. All exterior exposed steel items, including galvanized and zinc plated items unless otherwise indicated.
2. All exterior exposed non-factory finished steel mechanical and electrical items, including galvanized and zinc plated items.
3. Interior exposed steel items where indicated or specified to receive a steel coating.

B. Related Sections:

1. Construction waste management is specified in Division 01.
2. Structural steel is specified in Section 05 12 00.
3. Painting is specified in Section 09 91 13
4. Plumbing items are specified in Division 22.
5. Heating, ventilating, and air conditioning items are specified in Division 23.
6. Electrical items are specified in Division 26.

1.03 SUBMITTALS

A. General: Comply with the requirements in Division 01.

B. Product Data: Manufacturer's descriptive data fully describing each product to include solids by volume and complete test data comparable to specified products. Include manufacturer's recommendations for mixing, thinning, and curing.

C. Certificates: Manufacturer's certified test reports confirming compliance with specified performance requirements.

D. Samples: Two 5-inch x 7-inch samples of each selected color. Resubmit until approved by the Architect.

E. LEED Submittals:

1. MRc2 – Environmental Product Declarations (EPD): Furnish Manufacturer’s Life Cycle Analysis conforming to ISO 14044, Industry-wide (generic) EPD with third-party Type III certification, or Product-specific Type III EPD.
2. MRc4 – Material Ingredients: Furnish manufacturer’s Declare Label, Health Product Declaration (HPD), Cradle to Cradle Certification, Cradle to Cradle Health Product Certificate, or publicly available inventory of all ingredients identified by Chemical Abstract Service Registration Number (CASRN) down to 1000 ppm or less.
3. IEQc2 – Low Emitting Materials – Paints & Coatings: For paints and coatings applied onsite, furnish product data indicating the Volatile Organic Compound

(VOC) (g/L), compliance with California Department of Public Health (CDPH) v1.1-2010 emissions testing, and volume of product used (L).

1.04 QUALITY ASSURANCE

A. Applicator: Applicator shall have a minimum of 3-years' experience in the application of special coatings of the types required for this Project.

B. Coatings shall comply with current VOC requirements regulating the amount of volatile organic compounds.

1.05 PRODUCT DELIVERY, STORAGE, HANDLING:

A. General: Comply with the requirements in Division 01.

B. Deliver materials in factory-sealed containers with manufacturer's labels intact and legible.

C. Store materials in a protected area at a temperature between 35-deg. F. and 110-deg. F.

1.06 JOB CONDITIONS

A. Apply coating only under the following prevailing conditions:

1. The air and surface temperatures are not below 50-deg. F. or above 135-deg. F.

2. Relative humidity is not above 85-percent and the surface temperature is at least 5-deg. F. above the dew point.

B. Protect surfaces not to be coated.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Tnemec Company or equal products by Ameron. Substitutions will be considered only where substitution's test data provide sufficient information to demonstrate equal or better performance for all listed tests and color availability.

2.02 MATERIALS

A. Organic zinc-rich primer, 90-97 Tneme-Zinc.

1. Adhesion: Not less than 1500-psi pull, average of three trials, ASTM D4541, Type II

2. Salt Spray (Fog): No blistering, cracking, spot rusting or delamination of film after 10,000 hours. No more than 1/64-inch rust creep at scribe and no rusting at edges after 3,000 hours exposure, ASTM B117.

3. Solids by Volume: Not less than 63 percent + or – 2%.

4. Zinc Dust Content: 83.0-percent + or - 2 by weight in dry applied film.

5. Zinc dust must meet requirements of ASTM D 520 Type III

B. Organic zinc-rich primer, 94-H_2O Hydro-Zinc.

1. Adhesion: Not less than 1500-psi pull, average of three trials, ASTM D4541, Type II

2. Salt Spray (Fog): No blistering, cracking, spot rusting or delamination of film after 10,000 hours. No more than 1/64-inch rust creep at scribe and no rusting at edges after 3,000 hours exposure, ASTM B117.

3. Solids by Volume: Not less than 62 percent + or – 2%.
4. Zinc Dust Content: 83.0-percent + or - 2 by weight in dry applied film.
5. Zinc dust must meet requirements of ASTM D 520 Type III
6. Not more than 100 g/l VOC

C. Polyamidoamine Epoxy, Series V69 Hi-Build Epoxoline II

1. Abrasion: No more than 140-mg. loss after 1,000-cycles, ASTM D4060, CS-17 Wheel, 1,000 grams load.
2. Adhesion: Not less than 1,600 PSI, ASTM D4541, Type II Fixed Alignment Adhesion Tester.
3. Humidity: No blistering, cracking, softening or delamination of film after 10,000-hours, ASTM D4585.
4. Salt Spray (Fog): No blistering, cracking, or delamination of film. Not more than 1% rusting on plane. Not more than 1/16" rust creep at scribe after 6,700 hours exposure, ASTM B117.
5. Solids by Volume: Not less than 67 percent + or – 2%.
6. Not more than 250 g/ l VOC
7. Colors: To be selected by the Architect.

D. Polyamidoamine Cured Epoxy, Series L69 Epoxoline.

1. Abrasion: No more than 140-mg. loss after 1,000-cycles, ASTM D4060, CS-17 Wheel, 1,000- grams load.
2. Salt Spray (Fog): No blistering, cracking or delamination of film after 5,000-hours, ASTM B117.
3. Adhesion: ASTM D 4541 Type II, not less than 1,500 psi pull avg. of 3 trials.
4. Solids by Volume: Not less than 65 percent + or – 2%.(mixed)
5. Not more than 100 g/l VOC

E. Aliphatic acrylic polyurethane, Series 1075 Endura-Shield II.

1. Abrasion: No more than 139-mg. loss after 1,000-cycles, ASTM D4060, CS-17 Wheel, 1,000 grams load.
2. Adhesion: Not less than a rating of 5, average of three tests, ASTM D3359 Method B.
3. Humidity: No blistering, cracking, softening or delamination of film after 4,000-hours, ASTM D4585.
4. Salt Spray (Fog): No blistering, cracking, rusting or delamination of film. Not more than 1/16" rust creep at scribe after 2,000 hours exposure, ASTM B117.
5. Solids by Volume: Not less than 71 percent + or – 2%.
6. QUV: No blistering, cracking or chalking. No less than 98% gloss retention and 2.25 DED FMCII color change after 5,000 hours exposure, ASTM D 4587.
7. Not more than 250 g/ l VOC
8. Colors: To be selected by the Architect.

F. Waterborne Acrylic Polyurethane, 1081 (semi-gloss) or 1080 (gloss) Endura-Shield WB.

1. Abrasion: No more than 83-mg loss average of three trials after 1,000-cycles, ASTM D4060, CS-
2. Adhesion: No less than 1,650-psi average of three trials, ASTM D4541, Type II.
3. Humidity: No blistering, cracking, softening or delamination of film after 2,000-hours, ASTM D4585.
4. Salt Spray (Fog): No blistering, cracking, softening or delamination of film and no more than 1/32- inch rust creepage at scribe after 6,000-hours exposure, ASTM B117.
5. QUV: No blistering, cracking or chalking. No less than 98% gloss retention and 2.25 DED FMCII color change after 5,000 hours exposure, ASTM D 4587.
6. Not more than 100 g/ l VOC
7. Solids by Volume: 58.0-percent + or - 2 (mixed).
8. Colors: To be selected by the Architect.

G. Waterborne acrylic polyurethane, 1081 (semi-gloss) or 1080 (gloss) Endura-Shield WB.

1. Abrasion: No more than 83-mg. Loss average of three trials after 1,000-cycles, ASTM D4060, CS-17 Wheel, 1,000-grams load.
2. Adhesion: No less than 1,650 psi average of three trials, ASTM D4541, Type II.
3. Humidity: No blistering, cracking, softening or delamination of film after 2,000-hours, ASTM D4585
4. Salt Spray (Fog): No blistering, cracking, softening or delamination of film and no more than 1/32 inch rust creepage at scribe after 5,000-hours exposure, ASTM B117.
5. QUV: No blistering, cracking or chalking. No less than 98% gloss retention and 2.25 DED FMCII color change after 5,000 hours exposure, ASTM D 4587.
6. Not more than 100 g/ l VOC
7. Solids by Volume: 58.0-percent + or - 2 (mixed).
8. Colors: To be selected by the Architect.

2.03 MATERIAL PREPARATION

A. Mix and thin materials according to manufacturer's latest printed instructions.

B. Do not use materials beyond manufacturer's recommended shelf life.

C. Do not use mixed materials beyond manufacturer's recommended pot life.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine surfaces to be coated and report conditions that would adversely affect appearance or performance of coating systems and which cannot be put into an acceptable condition by preparatory work as specified.

B. Do not proceed with surface preparation and application until surface is acceptable or authorization to proceed is given by Architect.

3.02 SURFACE PREPARATION

A. General:

1. Dislodge dirt, rust, mortar spatter and other dry material by scraping or brushing. Remove dust and loose material by brushing, sweeping, vacuuming or blowing with high-pressure air.

2. Remove oil, wax and grease by scraping off heavy deposits and cleaning with mineral spirits or a hot trisodium phosphate solution followed by a water rinse.

3. Verify that surfaces to be coated are dry, clean and free of dust, dirt, oil, wax, grease or other contaminants.

B. Galvanized and Zinc Electroplated Steel:

1. Remove all soluble and insoluble contaminants and corrosion. Sweep (abrasive) blast in accordance with ASTM D6386 to achieve a uniform anchor profile (1.0 to 2.0 mils).

2. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods, then chemical etch using Clean ‘n Etch or Galvaprep 5.

C. Non-galvanized Steel: Exposed surfaces and surfaces specified to receive zinc-rich primers shall be cleaned in compliance with SSPC-SP6 and receive coating before rusting occurs.

3.03 APPLICATION

A. Apply materials at manufacturer’s recommended film thickness using either air or airless spray equipment recommended by manufacturer. At perforated metal, apply material at thinner film thickness and increase the number of coats if required to eliminate filling perforations with coating and as required for acceptable coverage and appearance.

B. Allow each coat to dry thoroughly before re-coating. Follow manufacturer's recommended re-coat time.

C. Cut edges clean and sharp where work joins other materials or colors.

D. Make finish coats smooth, uniform in color, and free of brush marks, laps, runs, dry spray, over-spray and skipped or missed areas.

E. Paint visible surfaces of ducts where visible through registers or grilles with a flat, non-specular black finish.

F. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

G. Omit primer on metal surfaces that have been shop primed and touch-up painted, unless otherwise indicated.

3.04 INSPECTION

A. Request acceptance of each coat before applying succeeding coats.

B. Repair and touch-up work that is not acceptable to the Architect and request final acceptance.

3.05 CLEANING

A. Remove paint spatters from glass, plumbing fixtures and adjoining surfaces.

B. Repair damage to coatings or surfaces caused by cleaning operations.

C. Remove debris from jobsite and leave storage areas clean.

3.06 COATING SCHEDULE

A. Exterior Use (Non-galvanized Steel)

1. First Coat: 90-97 Tneme-Zinc at 2.5 to 3.5 mils dry film thickness.
2. Second Coat: Series V69 Hi-Build Epoxoline at 2.0 to 3.0 mils dry film thickness.
3. Third Coat: Series 1075 Endura-Shield at 2.0 to 3.0 mils dry film thickness.
4. Fourth Coat: Series 1075 Endura-Shield at 2.0 to 3.0 mils dry film thickness.
    a. Note third and fourth coats may be spray applied as a single 4.0-5.0 mil dry film thickness coat provided surface finish requirements are maintained.

B. Exterior Use (Galvanized, Zinc Plated Steel, Stainless Steel & Aluminum where Indicated**)**

1. Touch-up of damaged galvanized surfaces: 90-97 Tneme-Zinc at 2.5 to 3.5 mils dry film thickness.
2. First Coat: Series V69 Hi-Build Epoxoline at 2.0 to 3.0 mils dry film thickness.
3. Second Coat: Series 1075 Endura-Shield at 2.0 to 3.0 mils dry film thickness.
4. Third Coat: Series 1075 Endura-Shield at 2.0 to 3.0 mils dry film thickness.
    a. Note second and third coats may be spray applied as a single 4.0-5.0 mil dry film thickness coat provided surface finish requirements are maintained.

C. Interior Use (Non-Galvanized Steel)

1. First Coat: 94-H_2O Hydro-Zinc at 2.5 to 3.5 mils dry film thickness.
2. Second Coat: Series L69 Hi-Build Epoxoline at 2.0 to 3.0 mils dry film thickness.
3. Third Coat: Series 1081 Endura-Shield WB at 2.0 to 3.0 mils dry film thickness.
4. Fourth Coat: Series 1081 Endura-Shield WB at 2.0 to 3.0 mils dry film thickness.
5. Note third and fourth coats may be spray applied as a single 4.0-5.0 mil dry film thickness coat provided surface finish requirements are maintained.

D. Interior Use (Galvanized & Zinc Plated Steel):

1. Touch-up of damaged galvanized surfaces: 94-H2O Hydro-Zinc at 2.5 to 3.5 mils dry film thickness.
2. First Coat: Series L69 Hi-Build Epoxoline at 2.0 to 3.0 mils dry film thickness.
3. Second Coat: Series 1081 Endura-Shield WB at 2.0 to 3.0 mils dry film thickness.
4. Third Coat: Series 1081 Endura-Shield WB at 2.0 to 3.0 mils dry film thickness.

3.07 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with Division 01.

B. Set aside extra paint for future color matches or reuse as determined by Owner. Where paint recycling is available, collect all waste paint by type and provide for delivery to recycling or collection facility.

C. Close and seal tightly all partly used paint and finish containers and store protected in wel-ventilated, fire-safe area at moderate temperatures.

D. Place empty containers of solvent based paints in areas designated for hazardous materials.

E. Do not dispose of paints or solvents by pouring on the ground or drain. Place in designated containers for proper disposal.

END OF SECTION

SECTION 26 11 16.11

SECONDARY UNIT SUBSTATIONS – SECONDARY LESS THAN 1000 V

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the secondary unit substation(s) complete from the incoming line terminals to the outgoing line terminals as specified herein and as shown on the contract drawings.

B. The secondary unit substation shall consist of primary equipment, transformer and secondary equipment as specified below. The manufacturer of the unit substation shall furnish and coordinate all major components of the substations, including incoming primary equipment section, transformer and low-voltage section, as well as circuit breakers, fusible switches, and metering components. Provide a single warranty covering all substation assemblies, transformers and components.

C. Connections between the primary device and transformer shall be bus, and between the transformer and secondary shall be flexible bus braid.

D. Outdoor primary and secondary equipment where specified shall be of weatherproof construction, rodent proof and shall contain 120-volt space heaters, receptacles and lighting as required.

1.02 RELATED SECTIONS

A. Section 26 12 13 – Substation Transformers – Liquid-Filled

B. Section 26 13 16.13 – Medium Voltage Switches – 5/15 kV – Single Switch

C. Section 26 24 13.11 – LV Distribution Switchboards – Low Voltage (Group Mounted Feeders – Pow-R-Line C)

1.03 REFERENCES

A. The secondary unit substation shall be designed, assembled, tested and installed in accordance with latest applicable standards of NEMA, IEEE and ANSI, applicable to its three major sections:

1. MV Metal-Clad Switchgear – NEMA SG4, SG5; ANSI C37
2. MV Metal-Enclosed Switchgear – NEMA SG4, SG5; ANSI C37
3. MV Load Interrupter Switchgear – NEMA SG4, SG5; ANSI C37
4. MV Motor Controllers – ANSI/NEMA ICS-3-Part 2, UL347
5. Secondary Substation Transformers – NEMA 210, IEEE 100, ANSI C57
6. LV Metal-Enclosed Switchgear – ANSI C37, UL 1558
7. LV Distribution Switchboards – NEMA PB-2, UL 891

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. The following information shall be submitted to the Engineer:

1. Master drawing index
2. Front view elevation

3. Floor plan
4. Single line
5. Schematic diagram
6. Nameplate schedule
7. Component list
8. Conduit entry/exit locations
9. Assembly ratings including:
    a. Short-circuit rating
    b. Voltage
    c. Continuous current
    d. Basic Impulse level for equipment over 600 volts
    e. kVA
10. Major component ratings including:
    a. Voltage
    b. Continuous current
    c. Interrupting ratings
11. Cable terminal sizes
12. Connection details between close-coupled assemblies
13. Composite front view and floor plan of close-coupled assemblies
14. Impedance for transformers
15. Product data sheets

C. Where applicable, the following additional information shall be submitted to the Engineer:
    1. Busway connection
    2. Key interlock scheme drawing and sequence of operation

1.05 SUBMITTALS – FOR CONSTRUCTION

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. The following information shall be submitted for record purposes:
    1. Final as-built drawings and information for items listed Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
    2. Wiring diagrams
    3. Certified production test reports
    4. Installation information
    5. Seismic certification as specified

1.06 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Provide Seismic tested equipment as follows:

1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the [latest International Building Code (IBC)] [latest California Building Code (CBC) with OSHPD Amendments].

2. The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.

3. The IP rating of the equipment shall be 1.5

4. The Structural Engineer for the Site will evaluate the SDS values published on the Manufacturer’s website to ascertain that they are "equal to" or "greater than" those required for the Project Site.

5. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.

a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.

b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.07 REGULATORY REQUIREMENTS

A. Certified copies of production test reports shall be supplied demonstrating compliance with these standards when requested by the engineer.

1.08 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins, and renewal parts lists where applicable for the complete assembly and each major component.

PART 2 A PRODUCTS – PRIMARY EQUIPMENT

PART 2 B PRODUCTS – TRANSFORMERS

Liquid Transformers Section 26 12 13 – Part 2

PART 2 C PRODUCTS – SECONDARY EQUIPMENT

Switchboards Low Voltage
(Group Mounted Feeders – Pow-R-Line C) Section 26 24 13.11 – Part 2

PART 3 EXECUTION

3.01 FACTORY TESTING

A. Standard factory tests shall be performed on the primary equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

B. The following factory tests shall be made on all transformers. All tests shall be in accordance with the latest revision of ANSI and NEMA standards.

1. Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on this project
2. Ratio tests on the rated voltage connection and on all tap connections
3. Polarity and phase-relation tests on the rated voltage connections
4. No-load loss at rated voltage on the rated voltage connection
5. Exciting current at rated voltage on the rated voltage connection
6. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating on this project
7. Applied potential test
8. Induced potential tests
9. Temperature test(s) shall be made on all units. Tests shall not be required when there is available a record of a temperature test on an essentially duplicate unit. When a transformer is supplied with auxiliary cooling equipment to provide more than one kVA rating, temperature tests as listed above shall be made on the lowest kVA OA or AA rating and the highest kVA FA rating
10. ANSI impulse test on all primary windings

C. The following standard factory tests shall be performed on the secondary equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities
2. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute or 1800 volts for one second between live parts and ground, in accordance with ANSI C37.20.1

D. The manufacturer shall provide three (3) certified copies of factory test reports.

E. Factory tests as outlined above shall be witnessed by the owner's representative.

1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed

2. The manufacturer shall include the cost of transportation and lodging for up to three (3) owner's representatives. The cost of meals and incidental expenses shall be the owner's responsibility

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and startup of the equipment specified under this section for a period of 2 working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained herein.

B. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.04 TRAINING

A. The Contractor shall provide a training session for up to five (5) owner's representatives for 2 normal workdays at a job site location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall include instructions on the assembly including primary equipment, transformer, and secondary equipment. All circuit breakers, protective devices and other major components shall be included.

3.05 INSTALLATION

A. The contractor shall install all equipment per the manufacturer’s recommendation and the contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the contractor.

3.06 FIELD ADJUSTMENTS

3.07 FIELD TESTING

SECTION 26 12 13.01
LIQUID-FILLED, MEDIUM-VOLTAGE UNIT SUBSTATION TRANSFORMERS

PART 1 GENERAL

1.01 SCOPE

A. This specification covers the electrical and mechanical characteristics of three-phase substation distribution transformers.

1.02 APPLICABLE STANDARDS

A. All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of the following IEEE®, Department of Energy, and NEMA® standards.

1. IEEE Std C57.12.00™-2015 – IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. IEEE Std C57.12.28™-2014 – Sections 5.3, 5.4, 5.5 – Coating System Requirements
3. IEEE Std C57.12.36™- 2017 – IEEE Standard Requirements for Liquid-Immersed Distribution Substation Transformers
4. IEEE Std C57.12.70™-2011 – IEEE Standard for Terminal Markings and Connections for Distribution and Power Transformers
5. IEEE Std C57.12.90™-2010 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers
6. IEEE Std C57.154™ -2012 – IEEE Standard for the Design, Testing, and Application of Liquid-Immersed Distribution, Power, and Regulating Transformers Using High-Temperature Insulation Systems and Operating at Elevated Temperatures
7. NEMA® TR 1-1993 (R2000) – Transformers, Regulators and Reactors, Table 0-2 Audible Sound Levels
8. 10 CFR Part 431 – Department of Energy–Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule
9. IEEE Std 386™-2006 – IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Zetrak;

1. Contact: Roberto Rosario, Powersystems, Group, LLC (682-307-7380), robertr@pwrsystemsgroup.com , www.pwsystemsgroup.com

B. Or approved equal

2.02 RATINGS

A. The transformer shall be designed in accordance with this specification and the base kVA rating shall be:3750 kVA

B. The transformer shall have a high voltage and the basic lightning impulse insulation level (BIL) of 15 kV and 95 kV BIL

C. The low voltage and the basic lightning impulse insulation level (BIL) shall be 480Y/277V and 30 kV BIL.

D. The high voltage and low voltage connections of the transformer shall be:

1. [] Delta - Wye:

   a. For Delta - Wye configurations the low voltage neutral shall be a fully insulated X0 bushing. The low voltage shall lag the high voltage by 30°.

2. [X] Delta - Grounded Wye

   a. For Delta - Grounded Wye configurations the low voltage neutral shall be a fully insulated X0 bushing with ground strap. The low voltage shall lag the high voltage by 30°.

3. [] Delta - Delta

   a. For Delta - Delta configurations the transformer shall be provided without a neutral bushing. There shall be no phase shift between the high voltage and low voltage.

4. [] Grounded Wye - Wye

   a. For Grounded Wye - Wye configurations the high voltage neutral shall be internally tied to the low voltage neutral and brought out as the H0X0 bushing. There shall be no phase shift between the high voltage and low voltage.

5. [] Wye - Grounded Wye

   a. For Wye - Grounded Wye configurations the high voltage neutral shall be brought out as the Ho bushing on the high voltage side and the low voltage neutral shall be brought out as the X0 bushing with ground strap on the low voltage side. There shall be no phase shift between the high voltage and low voltage.

6. [] Wye - Delta

   a. For Wye - Delta configurations the high voltage neutral shall be brought out as the Ho bushing on the high voltage side. The low voltage shall lag the high voltage by 30°.

E. The transformer shall be furnished with full capacity high-voltage taps. The tap-changer shall be clearly labeled to reflect that the transformer must be de-energized before operating the tap-changer as required in Section 4.3 of IEEE Std C57.12.34™-2009 standard. The tap-changer shall be operable on the higher voltage only for transformers with dual high voltages. The unit shall have one of the following tap configurations:

1. [] No Taps
2. [X] Two – 2 ½% taps above and below rated voltage (split taps)
3. [] Four – 2 ½% taps below rated voltage (four below)
4. [] NEMA taps (14400, 13800, 13200, 12470, 12540)
5. [] Non-standard tap configuration: _____

F. The dielectric coolant shall be listed less-flammable fluid meeting the requirements of National Electrical Code® Section 450-23 and the requirements of the National Electrical Safety Code® (IEEE Std C2™-2002 standard), Section 15. The dielectric coolant shall be non-toxic*, non-

bioaccumulating and be readily and completely biodegradable per EPA OPPTS 835.3100. The base fluid shall be 100% derived from edible seed oils and food grade performance enhancing additives. The fluid shall not require genetically altered seeds for its base oil. The fluid shall result in zero mortality when tested on trout fry *. The fluid shall be certified to comply with the US EPA Environmental Technology Verification (ETV) requirements and tested for compatibility with transformer components. The fluid shall be Factory Mutual Approved®, UL® Classified Dielectric Medium (UL-EOUV) and UL® Classified Transformer Fluid (UL-EOVK), Envirotemp™ FR3™ fluid.

*(Per OECD G.L. 203)

G. The transformer, filled with Envirotemp™ FR3™ fluid, shall have a:

1. [] 65°C average winding temperature rise rating. The above winding temperature rise shall not exceed 65°C when loaded at base kVA rating.

2. [] 75°C average winding temperature rise rating. The above winding temperature rise shall not exceed 75°C when loaded at base kVA rating. This transformer is identified as a PEAK transformer.

3. [x] 55/65°C average winding temperature rise rating. The above winding temperature rise shall not exceed 55°C when loaded at base kVA rating. The transformer shall provide an additional 12% continuous operating capacity at the 65°C rating.

4. [] 65/75°C average winding temperature rise rating. The above winding temperature rise shall not exceed 65°C when loaded at base kVA rating. The transformer shall provide an additional 12% continuous operating capacity at the 75°C rating. This transformer is identified as a PEAK transformer.

5. [] 55/75°C average winding temperature rise rating. The above winding temperature rise shall not exceed 55°C when loaded at base kVA rating. The transformer shall provide an additional 22% continuous operating capacity at the 75°C rating. This transformer is identified as a PEAK transformer.

H. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 5 of IEEE Std C57.12.36™-2007 standard.

I. The transformer shall be cooled by the natural circulation of air over the tank surface, with future kVA capacity built into the cooling surfaces and conductors. The unit shall be provided with KNAN/Future KNAF rated cooling. Additional capacity ratings shall be as follows; 15% for 750-2,000 kVA, 25% for 2,500-10,000 kVA, 33% for 12,000 kVA

J. UL® Listing/Classification and FM® Approval

1. [x] The transformer shall be UL® Listed (certifying compliance with IEEE® standards only) per UL® XPLH.

2. [] The transformer shall be combination UL® Listed & Classified to comply with NEC® 450-23 listing restrictions for installations on, near, or inside of buildings per UL® XPLH.

3. [] The transformer shall be FM® Global (FM) Approved to comply with NEC® 450-23 listing restrictions for installations on, near, or inside of buildings.

2.03 CONSTRUCTION

A. The core and coil shall be vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system. While under vacuum, the windings will be energized to heat the coils and drive out moisture, and the transformer will be filled with preheated filtered degassed insulating fluid. The core shall be manufactured from burr-free, grain-oriented silicon steel and shall be precisely stacked to eliminate gaps in the corner joints. The coil shall be insulated with B-

stage, epoxy coated, diamond pattern, insulating paper, which shall be thermally cured under pressure to ensure proper bonding of conductor and paper.

B. Panel type radiators or corrugate type cooling are welded directly to the tank when additional cooling is required.

C. The tank must be welded using precision cut, cold-rolled steel plate and equipped with extra-heavy duty, welded-in-place lifting lugs and jacking provisions. The tank base must be designed to allow skidding or rolling in any direction.

D. The transformer shall be of sealed tank construction of sufficient strength to withstand a pressure of 7 psig without permanent distortion, and 15 psig without rupturing.

E. The tank shall include a pressure relief device as a means to relieve pressure in excess of pressure resulting from normal operation. The venting and sealing characteristics shall be as follows:

1. Cracking Pressure: 10 psig +/-2 psig
2. Resealing Pressure: 6-psig minimum
3. Zero leakage from reseal pressure to -8 psig
4. Flow at 15 psig: 50 SCFM minimum

F. The tank shall be cleaned with an alkaline cleaning agent to remove grease and oil. An iron phosphate coating shall then be chemically bonded to the metal to assure coating adhesion and retard corrosion. The tank shall be primed with an electrodeposited powder epoxy to provide a barrier against moisture, salt, and corrosives. The top-coat shall be a liquid polyurethane coating to seal and add ultraviolet protection. The tank coating shall meet all requirements in IEEE Std C57.12.28™-2014 standard.

G. The high voltage terminations shall each be enclosed with the following:

1. [] Throat
   a. A throat is used on a transformer with sidewall-mounted bushings for connecting the transformer with bus duct. It extends 8 inches above and below the centerline of the bushings.
2. [x] Flange (required with high voltage air disconnect switch)
   a. A flange is used on a transformer with sidewall mounted bushings for direct connection to metal clad switchgear and is required with the high voltage air disconnect switch option. The flange extends 8 inches above and 32 inches below the bushing centerline.
3. [] Partial height, bottom entry air terminal chamber
   a. The partial height bottom entry chamber extends approximately 24 inches below the centerline of the bushings and has a bottom removable plate that can accommodate cable glands or conduit hubs. The chamber shall include [a hinged door with padlockable handle and a [pentahead] [hexhead] bolt] [a lift-off front panel].
4. [] Partial height, top entry air terminal chamber
   a. The partial height top entry air terminal chamber has a chimney with a removable cover that extends 24 inches above the bushing centerline and can be equipped with cable glands or conduit hubs. Bus duct can be adapted to match the top of the chimney for bus termination. [a hinged door with padlockable handle and a [pentahead] [hexhead] bolt] [a lift-off front panel].
5. [] Full height, bottom entry cabinet

a. A full height bottom entry air terminal chamber is a weather-resistant metal enclosure around sidewall mounted bushings that extends downward to the transformer base level and upward approximately 10 inches above the bushing centerline. It is intended for underground feed and is provided with facilities for distribution arresters. [a hinged door with padlockable handle and a [pentahead] [hexhead] bolt] [a lift-off front panel].

6. [] Full height, top entry cabinet

a. A full height top entry air terminal chamber is a weather resistant metal enclosure around sidewall mounted bushings that extends downward to the transformer base level and upward approximately 24 inches above the centerline of the bushings. The chamber shall include [a hinged door with padlockable handle and a [pentahead] [hexhead] bolt] [a lift-off front panel].

H. The low voltage terminations shall each be enclosed with the following:

1. [x] Throat

a. A throat is used on a transformer with sidewall-mounted bushings for connecting the transformer with bus duct. It extends 8 inches above and below the centerline of the bushings.

2. [] Flange

a. A flange is used on a transformer with sidewall mounted bushings for direct connection to metal clad switchgear and is required with the high voltage air disconnect switch option. The flange extends 8 inches above and 32 inches below the bushing centerline.

3. [] Partial height, bottom entry air terminal chamber

a. The partial height bottom entry chamber extends approximately 24 inches below the centerline of the bushings and has a bottom removable plate that can accommodate cable glands or conduit hubs. The chamber shall include [a hinged door with padlockable handle and a [pentahead] [hexhead] bolt] [a lift-off front panel].

4. [] Partial height, top entry air terminal chamber

a. The partial height top entry air terminal chamber has a chimney with a removable cover that extends 24 inches above the bushing centerline and can be equipped with cable glands or conduit hubs. Bus duct can be adapted to match the top of the chimney for bus termination. [a hinged door with padlockable handle and a [pentahead] [hexhead] bolt] [a lift-off front panel].

5. [] Full height, bottom entry cabinet

a. A full height bottom entry air terminal chamber is a weather-resistant metal enclosure around sidewall mounted bushings that extends downward to the transformer base level and upward approximately 10 inches above the bushing centerline. It is intended for underground feed and is provided with facilities for distribution arresters. [a hinged door with padlockable handle and a [pentahead] [hexhead] bolt] [a lift-off front panel].

6. [] Full height, top entry cabinet

a. A full height top entry air terminal chamber is a weather resistant metal enclosure around sidewall mounted bushings that extends downward to the transformer base level and upward approximately 24 inches above the centerline of the bushings. The chamber shall include [a hinged door with padlockable handle and a [pentahead] [hexhead] bolt] [a lift-off front panel].

I. The tank shall be complete with an anodized aluminum laser engraved nameplate. This nameplate shall meet IEEE Std C57.12.00™-2015 standard for Nameplate B.

J. Overcurrent protection and switching

1. The optional overcurrent protection scheme provided with the transformer shall consist of one of following attributes. If for any reason a special protection scheme is required it shall be clearly stated on the inquiry.

    a. [] The high-voltage overcurrent protection scheme provided with the transformer shall be a loadbreak Bay-O-Net assembly with a flapper valve to minimize oil spillage. Overcurrent protection shall be provided by a Bay-O-Net expulsion fuse mounted in series with partial range under-oil ELSP current-limiting fuses with a maximum interrupting rating of 50,000 A rms symmetrical.

    b. [] Integral vacuum fault interrupter (VFI): (available from 13 amps up to 900 amps of full-load transformer current, up to 34.5 kV, grounded wye or delta, maximum 150 KV BIL) The high-voltage or low-voltage overcurrent protection scheme provided with the transformer shall be an integral Vacuum Fault Interrupter (VFI). The VFI shall have a maximum symmetrical interrupting rating of [12,000 A at 15 kV] [16,000 A at 15 kV] [12,000 A at 25 kV] [12,000 A at 35 kV] with resettable fault protection up through 35 kV. The VFI shall also include a Tri-Phase electronic breaker control with over 100 minimum trip settings and five (5) selectable time current curves. The minimum trip setting shall be XX amps, and curve profile shall be the EF, KF, TF, F, or H (Re: Bulletin B210-02039 and Service Information S285-75-1 for the electronic control).

        1) [] Optional ELSP Accessory: VFI shall be in series with ELSP under-oil partial-range current-limiting back-up fuses with an interrupting rating of 50,000 A.

        2) [] Optional TPG control

        3) [] Optional SCADA board (Requires TPG control)

        4) [] Optional motor operator assembly and control

        5) [] Optional motor operator provisions

        6) [] Optional [visible break window] [visible break and ground window]

    c. [x] Primary Air Load-break Switch 15kV 600A shall be provided that is in accordance with IEEE Std C37.20.3™-2013 standard and NEMA® SG-5. The switch shall include an EPR-insulated copper cable transition and provisions for mounting surge arresters. The switch shall be a three-pole, two-position gang operated air interrupter to include a manual stored energy mechanism for ease of operation. The switch shall be enclosed in modular self-supporting, bolted design including an electrostatically applied paint finish exceeding IEEE Std C37.20.3™-2013 standard and a 500 W cabinet heater. A 1200 A Primary Air Load-break Switch is available as an option. Note: The transformer must be specified with the High Voltage Flange in order to provide the primary air disconnect switch.

        1) [] The transformer primary shall be non-fused. It shall include a copper bus transition to the transformer. Note: Required when full load current exceeds 600A.

        2) [] The transformer primary air load-break switch shall include non-disconnect power fuses.

        3) [] The transformer primary air load-break switch shall include disconnect power fuses.

        4) [x] The transformer primary air load-break switch shall include current-limiting non-expulsion power fuses.

2.04 ACCESSORIES

A. The following standard accessories shall be provided:

    1. De-energized tap-changer

2. 1.0” upper fill plug with filter press connection
3. 1.0” drain valve with sampling device
4. Cover-mounted automatic pressure relief device
5. Welded cover with bolted manhole
6. Lifting lugs (4)
7. Liquid level gauge
8. Dial type thermometer
9. Pressure/vacuum gauge
10. SS ground pads (4)
11. Nitrogen blanket with purge valve
12. Touch-up paint (2 aerosol cans)

B. The following optional accessories shall be provided if specified:

1. [] Copper low voltage bushings (standard with all-copper windings)
2. [] Bleeder valve
3. [x] NEMA® 4 control box (standard with fan package)
4. [] NEMA® 4X control box (stainless steel)
5. [] NEMA® 7 control box (explosion proof)
6. [] Rapid pressure rise relay
7. [] Seal-in panel for rapid pressure rise relay
8. [x] Forced air fan control package
9. [] Winding temperature indicator
10. [] Auxiliary contacts for liquid level gauge
11. [] Auxiliary contacts for dial type thermometer (standard with fan package)
12. [] Auxiliary contacts for pressure/vacuum gauge
13. [] Auxiliary contacts for pressure relief device
14. [] 1.0” globe-type upper fill valve

C. Special Features

1. The following special features may be provided if specified:
2. [x] All copper windings

2.05 FINISH PERFORMANCE REQUIREMENTS

A. The tank coating shall meet all requirements in IEEE Std C57.12.28™-2014 standard including:

1. Salt Spray
2. Crosshatch adhesion

3. Humidity
4. Impact
5. Oil resistance
6. Ultraviolet accelerated weathering
7. Abrasion resistance–taber abraser

PART 3 EXECUTION

3.01 PRODUCTION TESTING

A. All units shall be tested for the following:

1. Ratio, polarity and phase relation tests using all tap settings
2. Winding resistance measurement tests
3. Insulation power factor
4. Full wave and reduced wave impulse test
5. Applied and Induced potential tests
6. No-Load losses at rated current
7. Total losses at rated current
8. Percent impedance at rated current
9. Excitation current (100% voltage) test
10. Leak test

B. Transformers shall conform to efficiency levels for liquid immersed distribution transformers, as specified in the Department of Energy ruling “10 CFR Part 431 Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule; April 18, 2013.” Manufacturer shall comply with the intent of all regulations set forth in noted ruling (commonly referred to as DOE 2016).

C. The manufacturer shall provide certification upon request for all design and other tests listed in IEEE Std C57.12.00™-2010 standard, including verification that the design has passed short circuit criteria per IEEE Std C57.12.00™-2010 and IEEE Std C57.12.90™-2010 standards.

D. In the event of proposal bid evaluated with guaranteed losses due to a loss evaluation (see section 11.0), manufacturer shall conform to guaranteed average losses as specified in IEEE Std C57.12.00™-2010 standard. The no-load losses of a transformer shall not exceed the specified no-load losses by more than 10%, and the total losses of a transformer shall not exceed the specified total losses by more than 6%.

3.02 SHIPPING

A. Transformers shall be loaded and unloaded with overhead cranes. No pallet shall be provided.

3.03 DATA WITH PROPOSAL

A. The following data shall be submitted with the proposal:

1. Core losses (when requested per Sections 3.01 D and 2.04 D).
2. Winding losses (when requested per Sections 3.01 D and 2.04 D).

3. Percent impedance
4. Typical bid drawing

B. The following checked data shall be submitted with the proposal:

1. [] Exciting Current @ 100% and 110% rated Voltage.
2. [x] Efficiencies must be provided at loading levels of 100%, 75%, 50%, and 25%.
3. [] Percent regulation must be provided at 0.8 PF and 1.0 PF.

3.04 DRAWINGS

A. The following will be provided by request after receipt of order:

1. [x] Construction drawings
2. [x] Record drawings
3. [] Approval drawings
4. [] CAD drawings

3.05 SERVICE

A. The manufacturer of the transformer shall have regional service centers located within 2 hours flight time of all contiguous 48 states. Service personnel shall be factory trained in commissioning and routine service of quoted transformers.

SECTION 26 13 16.13

MEDIUM VOLTAGE LOAD INTERRUPTER SWITCHGEAR

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the medium voltage load interrupter switchgear as specified herein and as shown on the contract drawings.

1.02 RELATED SECTIONS

1.03 REFERENCES

A. The medium voltage load interrupter switchgear and all components shall be designed, manufactured and tested in accordance with the latest applicable standards as follows:

a. ANSI/IEEE C37.20.3

b. ANSI/IEEE C37.20.4

c. ANSI C37.22

d. ANSI C37.57, C37.58

e. CSA 22.2 No.31-M89 (5/15 kV ratings only)

f. EEMAC G8-3.3

B. Listing by Underwriters Laboratories (UL) or Canadian Standards Association (CSA) shall be provided for 5 kV or 15 kV class medium voltage load interrupter switchgear.

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:

a. Master drawing index

b. Front view elevation

c. Floor plan

d. Top view

e. Single line

f. Nameplate schedule

g. Component list

h. Conduit entry/exit locations

i. Assembly ratings including:

a. Short-circuit rating

b. Voltage

c. Continuous current

d. Basic Impulse Level

j. Major component ratings including:

a. Voltage

b. Continuous current

c. Interrupting ratings

k. Cable terminal sizes

B. Where applicable or required by the Engineer the following additional information shall be submitted to the Engineer:

a. Bus duct connection

b. Connection details between close-coupled assemblies

c. Composite floor plan of close-coupled assemblies

d. Electrical schematic diagram

e. Key interlock scheme drawing and sequence of operations

f. Descriptive bulletins

g. Product data sheets

1.05 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

a. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process

b. Wiring diagrams

c. Certified production test reports

d. Installation information including equipment anchorage provisions

e. Seismic certification as specified

1.06 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Provide Seismic tested equipment as follows:

a. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC) or latest California Building Code (CBC) with OSHPD Amendments, including OSHPD Special Seismic Certification (OSP) Pre-Approval.

b. The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.

c. The IP rating of the equipment shall be 1.5

d. The Structural Engineer for the Site will evaluate the SDS values published on the Manufacturer's or OSHPD website to ascertain that they are "equal to" or "greater than" those required for the Project Site.

e. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.

a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.

b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.07 REGULATORY REQUIREMENTS

1.08 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

B. Each switchgear assembly shall be split into shipping groups for handling as indicated on the drawings or per the manufacturer's recommendations. Shipping groups shall be designed to be shipped by truck, rail or ship. Shipping groups shall be bolted to skids. Accessories shall be packaged and shipped separately. Each switchgear shipping group shall be equipped with lifting eyes for handling solely by crane.

1.09 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton

B. IEM

C. Or approved equal

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and

manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 RATINGS

A. Switchgear assembly ratings shall be as follows:

a.	Nominal System Voltage	15 kV three-phase three wire
b.	System Grounding	Solid
c.	Main Cross Bus Continuous Current	600 A
d.	Maximum Design Voltage	15 kV
e.	BIL	95 kV
f.	Main Cross Bus Momentary Current (10 Cycle)	61 kA Asymmetrical RMS
g.	Main Cross Bus 2-Second short circuit current	38kA Symmetrical RMS
h.	Non-Fused Switch (Continuous and Load Break)	600Amperes
i.	Non-Fused Momentary withstand	40kA Asym rms
j.	Non-Fused Switch Fault close (3 times, minimum for 4.76 & 15 kV)	61kA Asymmetrical
k.	Non-Fused Switch 2-Second Short Circuit Current	38kA Sym RMS
l.	Type of Fuse	CLE
m.	Fuse Interrupting Rating	14.4 kA Sym RMS
n.	Fuse Rating	200 Ampere
o.	Fused Switch Fault close	23 kA Asym RMS

2.03 15 KV CONSTRUCTION

A. The metal-enclosed load interrupter switchgear shall consist of deadfront, completely metal-enclosed vertical sections containing load interrupter switches and fuses (where shown) of the number, rating and type noted on the drawings or specified herein.

B. The following features shall be supplied on every vertical section containing a three-pole, two-position open-closed switch:

a. A minimum 8-inch x 16-inch high-impact viewing window that permits full view of the position of all three switch blades through the closed door. The window shall not be more than 58 inches above the switch pad level to allow ease of inspection.

b. The door shall be interlocked with the switch so that:

a. The switch must be opened before the door can be opened

b. The door must be closed before the switch can be closed

c. A hinged grounded metal barrier that is bolted closed in front of every switch to prevent inadvertent contact with any live part, yet allows for a full-view inspection on the switch blade position

d. Provision for padlocking the switch in the open or closed position

e. Green OPEN, Red CLOSED switch position indicators with the words “Open” and “Closed” in French, Spanish and English

f. A hinged cover with rustproof quarter turn nylon latches over the switch operating mechanism to discourage casual tampering

g. The switch shall be removable from the structure as a complete operational component

C. Vertical section construction shall be of the universal frame type using die-formed and bolted parts. All enclosing covers and doors shall be fabricated from steel whose thickness shall be equal to or greater than those specified in ANSI/IEEE C37.20.3. No owner removable hardware for covers or doors shall be thread-forming type. To facilitate installation and maintenance of cables and bus in each vertical section, a split removable top cover and padlockable hinged rear door held closed by bolts shall be provided. A G90 grade galvanized base shall isolate equipment from contact with the concrete pad providing protection from rust. Heavy-duty hot dipped galvanized anchor clips shall be provided to anchor the switchgear to the concrete pad.

D. Each vertical section containing a switch shall have a single, full-length, flanged front door and shall be equipped with two (2) rotary latch-type padlockable handles. Provision shall be made for operating the switch and storing the removable handle without opening the full length door.

E. Each load interrupter switch shall have the following features:

a. Three-pole gang-operated mechanism

b. Manual quick-make, quick-break over-toggle-type mechanism that does not require the use of a chain or a cable for operation, and utilizes a heavy-duty coil spring to provide opening and closing energy

c. The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to tease the switch into any intermediate position under normal operation

d. Separate main and break contacts to provide maximum endurance for fault close and load interrupting duty

e. Insulating barriers between each phase and between the outer phases and the enclosure

f. A maintenance provision for slow closing the switch to check switch blade engagement and slow opening the switch to check operation of the arc interrupting contacts.

OR

2.04 BUS

A. All phase bus conductors shall be tin-plated copper.

B. Ground bus shall be silver-plated copper and be directly fastened to a galvanized metal surface of each vertical section, and be of a size sufficient to carry the rated (2-second) current of the switchgear assembly.

C. A neutral bus shall be provided only when indicated on the drawings. It shall be insulated for 1000 Vac to ground. The current rating of the neutral bus shall be 600 amperes.

2.05 BUS INSULATION SYSTEM

A. All bus shall be supported utilizing a high strength and high creep, support providing 10.5-inch of creep distance between phases and ground. The molded fins shall be constructed of high track resistant silicone rubber.

B. All standoff insulators on switches and fuse mountings shall be glass polyester.

2.06 WIRING/TERMINATIONS

A. One (1) terminal pad per phase shall be provided for attaching contractor-supplied cable terminal lugs for a maximum of two (2) conductors per phase of the sizes indicated on the drawings. Sufficient space shall be allowed for contractor supplied electrical stress relief termination devices.

B. Small wiring, fuse blocks and terminal blocks within the vertical section shall be furnished as indicated on the drawings. Each control wire shall be labeled with wire markers. Terminal blocks shall be provided for owner's connections to other apparatus.

2.07 FUSES

A. Fault protection shall be provided by fuses with continuous ratings as shown in the contract documents. Furnish three (3) spare fuses for each fused switch. Any fuse/switch integrated momentary and fault close ratings specified shall have been verified by test and UL and CSA certified.

2.08 OWNER METERING

A. Where indicated on the drawings, provide owner metering in the switch structure on a hinged panel to provide safe isolated access to meters and all associated terminal and fuse blocks for maintenance, calibration or testing while the gear is energized.

B. Provide ring-type current transformers for metering as shown on drawings. Current transformers shall be wired to shorting-type terminal blocks.

C. Voltage transformers or resistive voltage dividers shall be supplied as shown on the one-line diagram.

a. The voltage transformers shall be mounted on tilt-out trunnions or drawout drawer assemblies and equipped with current limiting primary fuses. In the withdrawn position, the fuses and the potential transformers shall be disconnected and grounded to permit safe inspection and/or replacement of the fuses. The trunnion frame shall be connected to ground by a flexible copper cable that is attached directly to the frame. The mechanism shall be arranged so that full access to potential transformers or fuses cannot be accomplished until they are disconnected from high voltage and grounded. Live parts shall be isolated when the voltage transformers are in the withdrawn position to prevent accidental contact by operating or maintenance personnel. Stationary contacts shall be silver plated copper and mounted on porcelain or glass polyester supports. Cables connected to voltage transformer primaries shall be rated for the full voltage and BIL rating of the switchgear.

b. Resistive voltage dividers can be used in place of voltage transformers. Resistive voltage dividers shall carry the same rating as the specified voltage transformers. They are to be mounted in the cable compartment of the switchgear assembly. Resistive voltage dividers must consist of 4 total non-inductive resistors (two paralleled medium voltage resistors and two paralleled low voltage resistors). When the nominal service voltage is applied, the resistive voltage divider system shall provide a 120 V signal to the auxiliary devices for protection and controls. The resistive voltage divider system shall be agnostic of the auxiliary devices to which they connect.

D. Microprocessor-Based Metering System.

E. Web-Enabled Communications

a. Where indicated on the drawings, provide a separate compartment with a front facing hinged door as a central point of connection for all internally located communicating devices to an external Ethernet network and allow monitoring of the power infrastructure with real-time, web-enabled data.

b. The compartment shall have a lockable, hinged door with a functional through-the-door RJ45 network access port. Power for the components in the compartment shall be supplied by a pre-wired, bus-connected control transformer in the compartment that is fused and has a disconnecting means.

c. The included communications components shall be a Power Xpert Gateway, which is specified in Section 16911 Communication equipment (TBD), where indicated on the drawings, shall have the following features:

d. The communication system network shall be Eaton PowerXpert Architecture

e. Each load interrupter switch position (open and closed), where shown, shall be communicated via an addressable relay. This relay shall communicate over the network. The relay shall monitor an auxiliary switch contact that monitors the primary switch position and shall be rated for the application. Each relay shall have a unique address so that it is possible to “call up” and “read” each load interrupter switch’s position from a host computer

f. A blown high voltage fuse condition on each set of three (3) fuses shall be monitored by an addressable relay. Any blown fuse operation shall be communicated immediately over the network via the monitoring addressable relay. Each relay shall have a unique address so that it is possible to “call up” and “read” a fuse blown operation for a set of fuses with the communication system

g. The manufacturer shall wire between all communication capable devices within the switchgear, including electronic meters with the same protocol and wire to a set of easily accessible terminal blocks

h. Control power for addressable relays shall be 120 volts, 60 Hz available from a fused control transformer.

2.09 ACCESSORIES

A. Supply key interlocks as shown on the drawings.

B. Furnish distribution class surge arresters with ratings in accordance with manufacture’s recommendations.

2.10 TRANSFORMER CONNECTIONS

a. A transformer primary load interrupter switch shall include the following when connecting to an indoor or outdoor liquid filled transformer, such as mineral oil, FR3, or silicone filled transformer

a. Cable or bus bar connection from the load side of the fuse (or load side of an unfused switch) to the HV bushing terminal pad on the primary of the transformer.

b. Include a connection for the ground bar to connect the switch enclosure to the transformer enclosure

2.11 A 20”W BUS TRANSITION SECTION SHALL BE PROVIDED. IF OUTDOOR, PROVIDE A 15” THROAT WITH A 5” FLANGE (20” ALTOGETHER) WITH FLANGE DIMENSIONS TO MATCH THE DIMENSIONS OF THE TRANSFORMER FLANGE.ENCLOSURES

A. Enclosures shall be constructed per IEEE/ANSI C37.20.3 Outdoor specifications. (Exceeds NEMA 3R.)

B. Each vertical section shall have a sloped weatherproof roof with labyrinth shaped joints. Use of gasket or caulking to make roof joints weatherproof shall not be permitted. All exterior openings shall be screened to prevent the entrance of small animals and barriered to inhibit the entrance of snow, sand, etc. A minimum of one (1) 250-watt, 120-volt space heater shall be provided in each vertical section. Power for the space heater(s) shall be furnished by a control power transformer mounted in the switchgear or by a transformer mounted within the low voltage switchboard/switchgear. The design shall be non-walk-in type.

C. Each vertical section shall be ventilated at the top and bottom, both front and rear, to allow airflow to provide cooling and help prevent buildup of moisture within the structure. The ventilated covers shall be externally removable to allow safe maintenance of the filter media without providing access to live parts.

2.12 NAMEPLATES

A. A nameplate shall be mounted on the front door of each switch vertical section in accordance with the drawings.

2.13 FINISH

A. Prior to assembly, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, then fused-on by baking in an oven. The coating is to have a thickness of not less than 1.5 mils. The finish shall have the following properties:

Impact resistance (ASTM D-2794)	60 direct/60 indirect
Pencil hardness (ASTM D-3363)	H
Flexibility (ASTM D-522)	Pass 1/8-inch mandrel
Salt spray (ASTM B117-85 [20])	600 hours
Color	ANSI 61 gray

PART 3 EXECUTION

3.01 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer’s representative to assist the Contractor in installation and startup of the equipment specified under this section for a period of 2 working days. The manufacturer’s representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The Contractor shall provide three (3) copies of the manufacturer’s field startup report.

3.03 MANUFACTURER’S CERTIFICATION

A. The Contractor shall provide a qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.04 TRAINING

A. The Contractor shall provide a training session for up to five (5) owner's representatives for 2 normal workdays at a job site location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative and consist of instruction on the assembly, switches and major components.

3.05 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

3.06 FIELD ADJUSTMENTS

3.07 FIELD TESTING

SECTION 26 0500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical submittals and product data.

B. Additional Electrical bid, workmanship, and installation requirements.

C. Common electrical implementation and closeout requirements.

1.02 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section covers general work of all Sections under Division 26.

C. The Division 26 Specifications and Drawings are complementary, what is called for by one is binding. Items shown on the Drawings are not necessarily included in the Specifications and vice versa.

D. Use the more stringent requirement when specified materials or methods exceed what is required by applicable Codes and Standards.

E. The following sections should be reviewed to ensure the requirements for this project are met:

1. Section 26 0573 – Electrical Power System Study
2. Section 26 0800 - Electrical Testing Requirements
3. Section 26 0801 - Commissioning of Electrical Systems

1.03 REFERENCES

A. Publications and standards listed below form a part of this specification to the extent referenced. The most recent version, adopted by the Authority Having Jurisdiction, will apply.

1. CEC - California Electrical Code, Title 24, Part 3, including all applicable Amendments and Supplements, as based on NFPA 70.
2. CBC - California Building Code, Title 24, Part 2
3. CMC - California Mechanical Code, Title 24, Part 4
4. CFC - California Fire Code, Title 24, Part 9
5. IBC – International Building Code
6. IECA - Insulated Cable Engineers Association
7. NFPA - National Fire Protection Association
8. NEMA - National Electrical Manufacturers Association
9. NECA - National Electrical Contractors Association
10. ANSI - American National Standards Institute
11. IEEE - Institute of Electrical and Electronic Engineers
12. UL - Underwriters Laboratories
13. CAL/OSHA - State of California Low-Voltage Electrical Safety Orders
14. CAL/OSHA - State of California High Voltage Electrical Safety Orders

15. Codes and regulations noted in other Sections in Division 26, applicable State and Local Codes and Ordinances.

B. If any of the requirements of the above Codes and Standards are in conflict with one another, or with the requirements of these specifications, the most stringent requirement shall govern. The Owner's Representative shall determine the most stringent requirement.

1.04 SUBMITTALS AND DEFERRED SUBMITTALS

A. Refer to Division 01 for additional requirements.

B. The project schedule shall be submitted to the Owner's Representative prior to acceptance of shop drawing submittals. The schedule shall include timeframe for mobilization, shop drawings, construction, milestone dates of critical path items to be installed, testing, adjusting, energization, commissioning, closeout documentation, and demobilization.

C. A written statement from the Contractor shall be included with each submittal that the equipment, hardware or accessory item complies with all the requirements of the project specification and associated drawings.

1. The Contractor shall submit the specification section showing compliance with each respective paragraph, specified items, and features that apply to the items included in the submittal.

2. All exceptions shall be clearly identified, in writing, by referencing respective paragraph and other requirements along with proposed alternative.

D. Submit all Division 26 shop drawings and product data grouped and referenced by the specification technical section numbers.

E. Provide separate submittal packages for equipment installed by the Contractor and operated by the Utility, and equipment installed by the Contractor and operated by the Owner.

1. For Owner Equipment, organize submittals in same sequence as they appear in Specification Sections, articles or paragraphs.

F. Shop Drawings and Deferred Submittals

1. Provide coordination and supplemental design shop drawings in PDF and unlocked with all reference files in AutoCAD (.dwg) or Revit format drawn to scale. Confirm with the Owner's Representative the version of AutoCAD or Revit required.

2. Provide all other shop drawings in PDF format. Provide a minimum of 8.5 inches by 11 inches paper size if required by Owner's Representative.

3. Shop drawings shall contain job title and references to the applicable specification section.

4. Include installation details for equipment including proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.

5. Internal wiring diagrams of equipment shall show wiring as actually furnished with equipment installed for this project and with all optional items clearly identified as included or excluded. Clearly identify external wiring connections. Identify and obliterate superfluous material.

6. Indicate adequate clearances for working space operation, maintenance, and replacement of operating equipment devices. Identify all access provisions and requirements.

7. For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, instruction manuals,

performance and characteristic curves if applicable, and catalog cuts. Identify model, catalog number, options included, ratings, Code and UL compliance for every item submitted for review. Include sufficient information to indicate complete compliance with Contract Documents. Use highlighting and arrows to identify required information and options being provided. Line thru options not being provided.

8. If equipment is not approved, revise the submittal to show acceptable equipment and resubmit in a timely manner.

9. If paper submittals are required, prepare submittal material in accordance with the following:

    a. Insert all literature in standard 3-ring binders for 8-1/2 inch by 11 inch pages with individual tabs. Do not staple literature on different products together.

    b. Provide 3 sets of the 3-ring binders with same original manufacturer's literature.

    c. Number all binders on the outside of the cover and indicate the Specification Section. Mark Binder No. 1 Engineers copy, and No. 2 Owner’s Representative copy.

    d. Provide an index with binder. This index shall follow the same sequence as the Specifications.

10. Product data, shop drawings and submittals: Submittals shall be prepared by the Contractor and delivered to the Owner’s Representative for approval and prior to purchase, fabrication, and installation for detailed product data, options, shop drawings, procedures and lists that are required in the specifications and on the plans including the following items, but not limited to:

    a. High / Medium voltage switchgear with Circuit Breakers and Electronic Control and Protection.

    b. Bus bars and termination sections and cabinets.

    c. Power Distribution Panelboards.

    d. Lighting and appliance panelboards.

    e. Individually mounted circuit breakers.

    f. Isolating switches.

    g. individual Starters, enclosures, and wiring diagrams.

    h. Dry-type Transformers.

    i. Liquid-filled Transformers.

    j. Control panel enclosures with associated components.

    k. Automatic Transfer Switches.

    l. Uninterruptable Power Supplies.

    m. Conduit and fittings. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

    n. Flexible Conduits, expandable fittings, and connection fittings.

    o. Cable tray, cable ladders, and fittings.

    p. Fasteners and supports for light fixtures, equipment, conduits, tray, pullboxes, and devices. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

q. Wireways.

r. Cabinets and boxes. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

s. Precast Concrete and Composite Concrete Polymer Underground Boxes. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

t. Precast Manhole and Equipment Vaults with cable racks and accessories. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

u. Lighting fixtures / pole lights and all associated equipment (lamps, ballasts, power supplies, controllers, photo and occupancy sensors, etc.). Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

v. Low / extra low voltage cables with associated splices and terminators.

w. High / Medium voltage cables with associated splices and termination accessories.

x. Power Metering Devices.

y. Surge Protective Devices.

z. Outlet Receptacles, Wall Switches, cover plates, and associated accessories. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

aa. Lighting Controls system devices, and accessories.

bb. Fiber Optic cable with associated splices and terminators.

cc. Fire Alarm control panels and devices.

dd. Grounding Connection Materials and accessories. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

ee. Conduit duct plug seals, sealing compound, and expandable seals. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

ff. Conduit penetration seals for water, fire stop, sound, air, and dust. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

gg. Equipment identification, hazard labeling materials, and nameplates. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

hh. Spreadsheet in Microsoft Excel of all information for each label or nameplate for power and communications equipment and cables to be submitted prior to fabrication and installation.

ii. Submit all switching procedures for all outages for all cutovers and connections of power cables and equipment.

jj. Cutover procedures for fiber and copper IT cabling.

kk. Light fixtures with fixture photometrics, lumen output, color temperature, and other features. Provide separate submittal packages for Utility and Owner equipment to be installed, for review by Utility and Owner Engineers.

G. Whenever more than one (1) manufacturer's product is specified in the project documents, the first named product is the basis of design and the use of alternate-named manufacturer's products or substitutes by the Contractor may require modifications in that design. If such alternatives are proposed or used by the Contractor, there may be additional design work required. The Engineers will provide the design fees to modify the issued drawings for the work to incorporate that alternate into the documents within 15 days of receipt of the substitution request. The Contractor shall pay all costs required to make necessary revisions and modifications to the design, including all professional fees to the Engineers for the evaluation and revisions or modifications of the documents resulting from the substitution or selection of an alternate manufacturer submitted by the Contractor.

H. All submittals must be delivered to the Owner's Representative within the number of days allowed after the Notice to Proceed or contract award. Failure to submit any or all items shall not result in a delay in the schedule or a schedule extension. If more time is required to compile a specific submittal, then a formal request in writing may be submitted, requesting more time. This request should list the item or system, the specification section involved, the reason for the delay, and the date when this item will be submitted. This will be reviewed by the Owner's Representative and a response regarding schedule and time extension will be prepared within one week.

I. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner's Representative bearing the Owner's Representative stamp of "Reviewed and Approved Without Comment", or "Approved with comment". All corrections or modifications required for equipment as noted on the shop drawings shall be made by the Contractor if equipment has been purchased or installed. Contractor shall pay all costs to remove equipment from the job site and/or returned at the request of the Owner's Representative, without additional compensation.

J. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute / Institute of Electrical and Electronics Engineers (ANSI / IEEE) or National Electrical Manufactures Association (NEMA), submit proof of such conformance to the Owner's Representative for approval. If an organization uses a label or listing from a Nationally Recognized Testing Laboratory (NRTL) to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, and where acceptable to Owner's Representative, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Owner's Representative. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material". The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. Certifications shall be documents prepared specifically for this Contract, printed on the manufacturer's letterhead, and signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

K. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.

L. Re-submittals will be reviewed for compliance with comment made on the original submittal only and should be marked with a resubmittal number and dated.

1.05 SUBSTITUTIONS

A. Coordinate with the requirements of Division 26, all applicable sections.

B. Products or systems listed as "no substitutions" or "no known equal" shall be provided as specified, "no equal".

C. Products or systems noted as "or equal": A product or system of equivalent design, construction and performance will be considered. Submit all pertinent data and product information for review. Provide the specified products or systems if proposed substitution is found unacceptable.

1.06 MATERIALS FURNISHED

A. Refer to applicable Division 26 Sections for complete product specifications, including Manufacturers' names and model numbers used for materials, processes or equipment, the standards of quality, utility, and appearance.

B. All approved switchgear, switchboards, motor control centers, transformers, panelboards, and circuit breakers shall be supplied from the same manufacturer and be new manufactured material and assemblies, purchased for this project.

C. All equipment shall be delivered to the job site bearing the label of Underwriters Laboratories, or other testing laboratory acceptable to authority having jurisdiction, where listing exists for the class of equipment.

D. For equipment specified by manufacturer's catalog number, include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified in project documents.

E. Where no specific make of material or equipment is mentioned, use products of reputable manufacturer that conform to requirements of system and other applicable specification sections.

F. Equipment and material damaged during transportation, installation, or operation is considered as totally damaged and will be replaced by Contractor with new. Variance from this requirement shall be permitted only with written approval from the Owner's Representative.

G. Provide an Owner's approved and authorized representative to constantly supervise Work specified. Check all materials prior to installation for conformance with Drawings, Specifications, and reviewed Shop Drawings.

H. Each purchase order or subcontract issued by the Contractor shall include project requirements for submittal data, startup services, commissioning, Operation & Maintenance (O&M) manuals, data and training.

1.07 WARRANTY

A. Comply with the requirements of Division 01, and all other project requirements.

B. Provide a written Contractor's one-year guarantee for all workmanship and materials installed for this project unless otherwise indicated to be longer in other Division 26 Sections. Guarantee period shall be effective from time of work acceptance or as defined in Division 01, whichever date succeeds the other.

C. Refer to project specifications for requirements to provide manufacturer's written warranty for all materials and equipment that includes all terms, conditions, exclusions, and duration.

D. Provide the Owner with extended warranty options when requested.

1.08 DEFINITION OF TERMS

A. The following terms used in Division 26 documents shall be defined as follows:

1. Provide: Shall mean furnish, install, connect, and test unless otherwise indicated.
2. Furnish: Shall mean purchase and deliver to project site.
3. Install: Shall mean to physically install and connect the items in-place.
4. Connect: Shall mean make final electrical connections for a complete operating piece of equipment or system.
5. Equal: Shall be of the same quality, appearance and utility to that specified, as determined by the Owner's Representative. The Contractor bears the burden of proof of equality.
6. Exposed: Shall mean exposed to view and readily accessible after construction is completed.
7. Concealed: Shall mean hidden from view after construction is completed.
8. Utility Area: Shall mean electrical, mechanical and communications equipment rooms, elevator machine room, equipment yards, and other locations where utility and utilization equipment and systems are installed.
9. As directed: Shall be as directed by the Owner's Representative.
10. As required: Shall be as required by project documents, applicable code requirements, good building practice, the conditions prevailing, the Owner, or the Owner's Representative.
11. As selected: Shall be as selected by the Owner's Representative.
12. Owner's Representative: Shall mean person/group designated by Owner to represent the Owner.
13. Inspector of Record (IOR): Shall mean the person who is responsible for inspecting and approving the installation, and the person who is the representative for the Authority Having Jurisdiction.
14. Extra low voltage: Shall mean voltages of less than 90 volts line to ground.
15. Low voltage: Shall mean voltages of over 100 volts line to neutral to maximum of 600 volts line to line.

PART 2 - INSTALLATION AND QUALITY

2.01 ELECTRICAL WORKMANSHIP AND QUALIFICATIONS REQUIREMENTS

A. The electrical project includes the entire scope of work included and referenced in the project documents including complete installation of equipment, cable, and materials required for a complete and operable system after completion of testing, energization, and commissioning of the new equipment. Contactor shall include all costs to achieve these requirements in Contract bid price.

B. Employment of any person on any job in the capacity of an electrician is not permitted unless such person has qualified for and holds a valid Journeyman Electrician Pocket Card or General Journeyman Electrician Certificate issued by the State of California Division of Apprenticeship Standards, except, Contractor may employ electrical helpers or apprentices on any job of electrical construction, new or existing, when the work of such helpers or apprentices is performed under the direct and constant personal supervision of a journeyman electrician holding a valid Pocket Card accepted by the State of California Division of Apprenticeship Standards:

1. Each Pocket Card carrying journeyman electrician will be permitted to be responsible for the quality of workmanship for a maximum of one helper or apprentice during any same time period, provided the nature of the work is such that good supervision can be maintained and the quality of workmanship achieved is the best and as required by the latest edition of the California Electric Code.
2. Before each journeyman electrician commences work, deliver to Owner's Representative at the project site, a photocopy of the journeyman's valid Pocket Card.
3. All splicing and termination work on systems operating in excess of 600V shall be performed exclusively by a Journeyman electrician with a minimum of 5 years verifiable work experience making the types of splices and terminations required in the project scope of work. The Journeyman electrician shall possess and provide evidence of training through completion of a certification program for making splices and terminations. The Contractor shall submit resumes and training certificates to the Owner's Representative for review and approval for all Journeyman electricians, who will be making splices and terminations, 30 days in advance of any work activity.

C. Make installation in a neat, finished and safe manner, according to the latest published NECA Standard of Installation under competent supervision.

2.02 SCHEDULE OF WORK

A. Coordinate with the requirements of Division 26, all applicable sections.

B. Provide full-time supervisory staff to coordinate and maintain work force for project work sequencing requirements as detailed in the Owner approved project schedule.

C. When requested by the Owner, submit a project recovery schedule to return the project to the approved completion dates.

2.03 SITE VISITATION

A. Coordinate with the requirements of Bidding and Contract Requirements, Instruction to Bidders.

B. Visit the site prior to bidding and become familiar with existing conditions and other factors that may affect the execution of work. Include all related costs in the initial bid proposal.

C. Contractor shall visit the site and verify dimensions and scale shown on the plans and details prior to submitting a bid. Scale and dimensions shown are diagrammatic and shall not be used in preparing a bid estimate or for ordering material and equipment.

2.04 SAFETY

A. The electrical installation shall comply with all regulations on safety aspects issued by the Labor Department and other authorities from time to time. These include but are not limited to the following:

1. Construction Sites (Safety) Regulations including California Code of Regulations, Title 8, Division 1, Department of Industrial Relations.1.
2. Factories and Industries Undertakings Electricity Regulations.
3. IEC 60364-7-704: Construction and Demolition Site Installation.
4. Electricity Ordinances.
5. Construction Site Safety Manuals and Cal-OSHA requirements.

B. Coordinate and provide all barriers, fences, covers, warning tape, and plaques required to warn and protect workers and the public from all hazardous conditions during performance

of the Work.

C. The Contractor shall ensure that all workers utilize Personal Protective Equipment required for each task necessary to complete the scope of work.

D. Provide all training and job site safety instructions for Contractor and Owner's personnel prior to performing construction activities. Conduct safety meetings prior to implementing switching procedures required for electrical system shutdowns and energization.

E. The Contractor shall designate a safety officer who will conduct daily observation of workplace activity to assure compliance with safe work practices required to safeguard workers and the public from hazards. Provide the Owner with weekly written reports on job site safety. Report any and all incidents to the Owner's Representative immediately.

2.05 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Examine site related work and surfaces before starting work of any Section.

C. Report to Owner's Representative, in writing, conditions which will prevent proper execution of this work.

D. Beginning work of any Section without reporting unsuitable conditions to Owner's Representative constitutes acceptance of conditions by Contractor. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.

E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.

F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom and working space consistent with these requirements.

G. Equipment: Install equipment and materials to facilitate service, maintenance, and repair or replacement of both electrical equipment and other nearby installations and systems. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

H. Right of Way: Give right of way to gravity and piping systems installed at a required slope.

I. Install work uniform, level and plumb, in relationship to lines of the building. Do not install any diagonal or otherwise irregular work unless so indicated on the drawings or approved by the Owner's Representative.

2.06 INSTALLATION

A. Provide a complete properly operating system for each item of equipment called for under this work. Installation shall be in accordance to equipment manufacturer's instructions, the best industry practices and the contract documents.

B. Review Shop Drawings for work done by other trades.

C. For the purposes of clarity and legibility the contract drawings are essentially diagrammatic. Verify all dimensions by field measurements.

D. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to comply with the Codes and coordinate installation with other systems and appurtenances.

F. Install systems, materials, and equipment to comply with approved submittal data, approved deferred submittal and coordination drawings, to greatest extent possible. Comply with arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Engineer.

G. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Rearrangement or relocation of electrical work that block access to mechanical duct inspection or servicing panels, valves, fire damper actuators and similar apparatus shall be done at Contractor's own expense.

H. Access to Equipment: Locate switches, trapeze hangers, and pullboxes to provide easy access for operation, repair, and maintenance, and if concealed, provide access doors and assist with layout. Access doors shall be installed by the framer and supplied by Electrical Contractor.

I. Where housekeeping pad is noted on drawings provide minimum 3-1/2 inch / maximum 4-inch high concrete housekeeping pads for floor mounted electrical equipment. Housekeeping pad should extend no more than 2-inches beyond the equipment enclosure unless otherwise noted.

J. Conduit Systems

1. Worked into complete, integrated arrangement with like elements to make work neat appearing, finished.

2. Where exposed, install parallel with walls or structural elements: vertical runs plumb; horizontal runs level or parallel with structure as appropriate: groups racked together neatly with straight runs and bends both parallel and uniformly spaced.

3. Install as high as practicable to maintain adequate head room shown or required. Coordinate with Work of other Divisions to achieve proper headroom. Arrange conduits to maximize space to install future raceways.

4. Clearance: Do not obstruct spaces required by code in front of electrical equipment, access doors, etc.

5. It shall be unacceptable to combine circuits, conduits, cables, pull boxes, or junction boxes of extra low voltage systems and low voltage systems. No combining of communications systems with power systems will be permitted, unless the combination is necessary for termination within an equipment assembly.

2.07 COORDINATION

A. Arrange and coordinate the electrical system installation with other trades to provide inserts, chases, slots, and openings in other building components during progress of construction, to allow for electrical installations. Do any cutting and patching required due to improperly located or omitted openings with the approval of the Owner's Representative, who must also approve any additional changes resulting from relocation or omission of openings. Cutting or drilling in any structural member is prohibited without prior written approval of the Owner.

B. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way priority for piping and conduit installed at required slope

4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

5. To allow for clearance of electrical systems, equipment, and materials installations with other building components.

C. Coordinate installation of required supporting devices, sleeves, and openings in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate installing large equipment requiring positioning before closing in the building.

E. Coordinate the exact placement of all concrete foundations or related concrete pads with concrete contractor that relate to electrical equipment.

F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

G. Coordinate work of this Division 26 with work of all other divisions. Conduct work in a manner to cooperate with all other trades for proper installation of all items of equipment. Consult the Drawings of all other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members and mechanical and plumbing work. Make installation in accordance with rough-in and wiring diagrams provided for Contractors use.

H. Verify the physical dimension of each item of electrical equipment to fit the available space. Contractor is responsible for coordinating electrical equipment space requirements with the allotted space provisions, and access for determining routes through the construction area for final installation.

I. Coordinate underground work with other contractors working on the site. Perform coordination with contractors installing storm sewer, sanitary sewer, water and irrigation lines, to avoid conflicts. Common trenches may be used with other trades, providing clearances required by codes, ordinances, and project requirements are maintained.

J. Perform tracing and identification of existing underground utilities before trenching and excavation. Make adjustments to conduit and duct bank routes and pullbox, handhole and vault locations and all electrical equipment as necessary to avoid interference and in order to complete the installation.

K. All underground duct banks shall be photographed and surveyed before backfill. Provide GPS coordinate data, based on the Owner's coordinate system, for all duct bank sections installed for the project. The GPS survey shall include manholes, location of utility system crossings, width and extents of duct bank, locations of bends, location of lateral ducts, and other features. Provide the GPS coordinates on the Contractor as-built plans during construction. Provide all GPS data in a Microsoft Excel spreadsheet and include drawing reference and location for each survey point.

L. Coordinate all aspects of the electrical power, telephone and other utility services with the appropriate serving utility or Owner as applicable.

2.08 DRAWINGS AND COORDINATION WITH OTHER WORK

A. Exact routing of wiring and locations of outlets, panels, etc., shall be governed by structural conditions, obstructions and existing conditions. Engineer reserves right, at no increase in price, to make any reasonable change in locations of electrical items, exposed at ceiling and/or on walls, to group them into orderly relationships and/or increase their utility. Contractor shall verify Engineer requirements in this regard prior to roughing-in.

B. Dimensions, location of doors, partitions, and similar physical features shall be taken from architectural drawings for exact location of outlets to center with Architectural features, panels, etc., at the approximate location shown on Electrical Drawings.

C. Verify dimensions and the correct location of equipment and coordinate with other trades for any requirement, notify Owner's Representative of all changes of location requirements before proceeding with the roughing-in of connection.

D. Mounting heights of brackets, outlets, etc., shall be as required to suit equipment served.

E. Drawings indicate, generally, routes of all branch circuits. All runs to panels are indicated as starting from nearest outlet, pointing in direction of panel. Continue all such circuits to panel as though routes were indicated in their entirety.

F. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any Work, carefully check and verify all dimensions, sizes, and mounting requirements with the approved submittals and drawings to see that the equipment being installed will fit into the spaces provided.

G. The Contractor shall be responsible for verifying that equipment being provided will fit dimensionally in locations shown on Drawings.

2.09 CONNECTIONS TO EXISTING WORK

A. Install new work and connect to existing work with minimum interference or interruption to existing facilities and systems.

B. Provide temporary power where indicated as being required to be provided by the Contractor during shutdowns of existing services.

C. Schedule all outages with written consent of Owner. Perform this work at no additional charges and at times authorized that do not interfere with normal operation of existing facilities.

D. Maintain continuous operation of existing facilities as required with temporary utility connections between new and existing work or with temporary generators.

E. Do not interrupt alarm and emergency systems without consent of Owner. Provide temporary systems to maintain alarms and emergency systems when required for occupancy.

F. Connect new work to existing work in neat and acceptable manner.

G. Restore existing disturbed work to original condition including finish, enclosure integrity, maintenance, continuity of wiring, and operability as required.

2.10 TEMPORARY FACILITIES

A. Provide temporary light, power, alarm, and detection services as necessary during the construction period and as required to maintain operation of existing systems and occupancy of facilities.

B. Existing building distribution equipment, devices, circuits, and power shall not be used for construction without written permission of the Owner.

C. Contractor shall provide temporary power apparatus, wiring, and outlets required for use for construction. Contractor shall provide and install temporary power meters and disconnects when connection to the Owner's utility source is permitted by the Owner. Owner shall be reimbursed for the direct cost of energy used by the Contractor.

2.11 NOISE CONTROL

A. Contractor shall refer to the project documents and identify locations where operating equipment and device noise, vibration restrictions, and limits are to be complied with based on Codes, Ordinances, or Owner's criteria.

B. Perform necessary sound rated wall sealing for the electrical work in compliance with project requirements.

C. Back to back or straight through boxes in walls are not permitted unless specifically noted on the drawings.

D. Route raceways along corridors or other noncritical noise space to minimize penetrations through sound rated walls. Seal raceway penetrations through sound rated walls.

E. Ballasts, contactors, starters, transformers and like equipment which are found to be noticeably noisier than other similar equipment installed for the project will be deemed defective and shall be replaced.

2.12 EQUIPMENT

A. Equipment Installation

1. Follow manufacturer's directions and recommendations in all cases where the apparatus and devices used on this contract are provided with directions covering points not shown on the drawings or covered in these specifications.

2. Provide complete electrical connections, and interconnections, for all items of equipment including incidental wiring, materials, devices and labor necessary for a finished working installation.

3. Where equipment ratings differ from those shown in the project documents, the Contractor shall be responsible to provide the required changes to supply the load. Submit all changes to the Owner's Representative for approval prior to installation.

4. Verify the location and method for connecting to each item of equipment prior to roughing-in.

5. Check voltage and phase of each item of equipment before connection.

6. Furnish all code required disconnects, whether or not specifically shown in the contract documents and manufacturer's literature.

B. Equipment Support and Seismic Restraint

1. Install equipment seismic anchorage in compliance with the IBC and California Amendments and requirements from the local agency having jurisdiction.

2. Securely fasten to the structural floor, and provide lateral bracing if required, for all freestanding electrical equipment such as transformers, switchboards, distribution boards, transfer switches and so forth.

3. Securely support fixtures from the building structure. Provide bracing and seismic restraints to limit motion during a seismic event.

4. Support all junction boxes, pull boxes, or other raceway terminating housings located above the suspended ceiling from the floor above, roof or penthouse floor structure to prevent sagging or swaying as shown on drawing details.

5. Securely support conduits and raceways from the building structure.

6. Minimum support capacity for all equipment devices: Not less than four times the ultimate weight of the object being supported from the building structure or anchored to the structural floor, or structural engineer's specified supports based on structural engineer's calculations and details

7. Seismic Protection Criteria: Electrical equipment installations shall be protected from earthquakes. Seismic anchorage requirements of the CBC apply to this project. Protection criteria shall be a Horizontal Force Factor as prescribed by the CBC multiplied by the equipment weight considered passing through the machinery center of gravity in any horizontal direction.

a. Unless vibration isolation is required to protect equipment against structure transmitted noise and/or vibration, equipment shall be protected from earthquakes by rigid structurally sound attachment to the load supporting structure. The force factor and anchorage shall be determined by calculations performed by a registered California Structural engineer whether the isolators are present or not.

b. Vibration isolated equipment shall be protected by protected spring isolators. Seismic snubbers and protected spring isolators shall be seismic protection rated in three principal axes by independent laboratory testing or analysis by an independent licensed structural engineer.

c. Construction of all electrical gear, and equipment such as switchgear, switchboard, motor control center, panelboard, transformer and similar equipment shall meet seismic requirements per the CBC and IBC.

d. If structural plans and details do not call out the seismic supports or has changed the method of attachment per plans then the Contractor shall be responsible for the design of his own seismic restraint systems. Contractor shall provide structural calculation and shop drawings for electrical equipment support. These drawing and calculations shall be prepared, sealed and signed by a Registered California Structural Engineer, and submitted for review and approval.

e. Seismic protection, labor, materials and design shall be included in the Contract bid price.

C. Equipment Alignment

1. Install panels, cabinets and equipment level and plumb, parallel with structural building lines. Join switchgear, panels and electrical enclosures so that they fit neatly together without gaps, openings or distortion.

2. Fit surface panels, devices and outlets with neat, appropriate trims, plates or covers, without over-hanging edges, protruding corners or raw edges, to leave a finished appearance.

3. Install to facilitate service, maintenance, repair or replacement of components and in compliance with CEC clearances and other articles as appropriate. Connect for ease of disconnecting, with minimum interference with other installations. Removable elements shall move freely, without binding, when being installed or removed.

2.13 POWER AND COMMUNICATIONS SWITCHING

A. Confine the extent of each service interruption to the smallest collection of equipment necessary to safely perform testing, tie-in and cut-over.

B. Coordinate with Owner for interruption of services necessary to accomplish the Work.

C. Coordinate with Owner for interruption of services and connections to other projects on campus.

D. Coordinate with utility company and Owner all work associated with utility company power and communications distribution systems.

E. Placing equipment in service: Electrical equipment shall not be energized or placed in service until all pre-energization tests and inspections are complete and approved by the Owner, IOR, and PG&E, Notify Owner, and all interested parties, 2 weeks in advance of the date various items of equipment will be complete. Cleaning and all pre testing shall be completed and approved before energizing.

F. Prepare and submit switching procedures for all outages for all cutovers and connections of power and communications cables and equipment. Submit these switching procedures for Owner's review and approval 30 days before work is required. Only approved switching procedures shall be performed. All switching procedures are the responsibility of the Contractor. Each switching plan shall contain the following information as a minimum:

1. A switching plan shall be prepared for each work sequence that requires installation of new supply conductors, interruption of normal service to a building or individual loads.
2. Include in switching procedure the Owner's and all third party required activities to ensure close coordination and safety.
3. Switching plan is to identify the work area designation where work will be taking place and all loads and systems that will be affected.
4. Switching plan to identify requirements for cable and equipment testing or other tests to be performed in the sequence they are required to occur.
5. Where new cable and equipment is involved, switching plan is to identify that all cable and equipment acceptance testing has been completed and accepted prior to proceeding with the procedure.
6. Identify measures for verification by voltage testing where circuits are required to be de-energized for work.
7. Identify measures for verification of conductor voltage phase sequence by phase testing.
8. All circuits shall be tested for proper phasing upon energization and prior to supplying loads or interconnection of existing circuits. Phasing of new circuits shall match existing phasing of all existing circuits and sources.
9. The switching plan is a safety measure and also used as a check list to account for each required step. Specific switch ID and switch position status for each switch or circuit breaker that requires a specific status must be identified.
10. On reaching the completion of work to complete the work in the procedure, the switching plan will include the switching necessary to restore the power system to "normal" conditions, or operating state required by the Owner upon completion of the procedure.
11. A signature/initials column is required on the switching plan for verification/acknowledgement of each complete step by the Person-In-Charge. Without signature/initials of a completed step the next step is not allowed to be performed.

2.14 CUTTING AND PATCHING

A. Coordinate necessary cutting and patching for the electrical work in compliance with Division 26.

B. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

C. Neatly patch and finish any surface damaged by this work to match adjacent undisturbed surfaces; for instance, repair surfaces where raceways pass through finished floors or walls. Install new fireproofing where existing firestopping has been disturbed. Clean and remove all dirt and debris. Perform this work to the satisfaction of the Owner's Representative.

D. Where equipment installations or connections require the installation of an access panel, provide a properly sized and installed access panel similar to those used for mechanical equipment access.

2.15 PROTECTION OF WORK

A. Protect all electrical work and equipment against damage by other trades, weather conditions or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.

B. Keep all electrical equipment covered or closed to exclude dust, dirt and splashes of plaster, cement or paint and shall be free of all such contamination before acceptance. Keep enclosures and trims in new condition, free of rust, scratches and other finish defects. If damaged, properly refinish in a manner acceptable to the Owner's Representative.

C. Provide a temporary source of power to energize circuits, such as heaters and battery systems that are required to protect the equipment from damage or other deteriorating agents.

PART 3 - EXECUTION

3.01 EQUIPMENT IDENTIFICATION AND LABELING

A. Refer to Section 26 0553 - Identification for Electrical Systems for identification requirements.

B. Refer to Section 26 0573 – Electrical Power System Study for Arc Flash Hazard label printing requirements.

3.02 CLEANING AND PAINTING

A. Clean interior and exterior surfaces of equipment and raceways of all dirt, cement, plaster, and other debris. Protect interior of equipment from dirt during construction and clean thoroughly before energizing.

B. Clean out cracks, corners and surfaces on equipment to be painted, remove grease and oil spots so that paint may be applied without further preparation. Include surface preparations, priming, and finish coating for electrical cabinets, exposed conduit, pull and junction boxes.

C. Refinish and touch up paint:

1. Clean damaged and disturbed surface areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer. Paint color to match existing color.

4. Repair damage to PVC surfaces or paint finishes with matching touchup coating recommended by manufacturer.

D. Refinish or replace Work supplied with final finish equivalent to new condition if damaged to satisfaction of Owner‘s Representative.

E. After other Work is accomplished, thoroughly clean exposed conduit, panels (interiors and exteriors), fixtures, and equipment and leave in satisfactory condition, free of debris, dirt, dust, and other contaminants.

3.03 FIELD QUALITY CONTROL

A. After installation inspect installed components for damage and faulty work, including the following, but not limited to:

1. Electrical component supporting devices.
2. Electrical equipment components.
3. Raceways
4. Concrete bases.

B. Correct all items identified as a result of inspections and observations during construction in a timely manner.

C. Correct all items identified in the Owner's final inspection lists prior to energization and final acceptance of the Work.

3.04 ADJUSTING

A. Coordinate the requirements of all sections of Division 26.

B. Voltage Check

1. At job completion, check voltage at several points of utilization for power equipment installed under this work with installed loads energized to achieve maximum system load.
2. Adjust transformers taps for acceptable voltage level at the main service switchboard to ±2% of nominal systems voltage under maximum load. If proper voltage cannot be obtained, inform the Owner's Representative and the serving utility company.
3. Measure and verify the maximum voltage drop on feeders does not exceed 2% and maximum voltage drop on branch circuits does not exceed 3%. The total voltage drop at the final load source terminals, or outlets, shall not exceed 5%. Voltage drop shall be measured verified under maximum load conditions.

C. Phase Rotation Test

1. Measure Phase Rotation prior to 12000V feeder cutover.
2. Record phase rotation prior to de-energizing existing 12000V services and feeders.
3. Reconnect new feeders in same phase sequence.
4. Measure phase rotation of new 12000V service and 12000V feeders prior to energization. Correct phase connections as necessary to maintain same phase sequence to buildings.

3.05 POWER SYSTEM STUDIES

A. See Section 26 0573 – Electrical Power System Study for a complete list of what is required.

B. Work required by Section 26 0573 - Electrical Power System Study and support shall be included in the Contract bid price.

C. Provide study submittal for approval. Refer to Division 01 for additional requirements. Power system study shall be submitted and approved prior to any protective device testing.

D. Provide study submittal in PDF format. Provide three (3) paper copies on a minimum of 8.5-inches by 11-inches paper size, if required by Owner's Representative,

E. Contractor shall be responsible to implement review comments for changes and corrections, including adjustments to coordination settings and graphs, shall be updated at no additional costs to Owner.

F. Contractor shall submit all requests for Owner and Utility information in writing. Contractor is responsible to request all information for the existing system from the Owner and Utility in a timely manner.

3.06 PROGRAMMING

A. SCADA system and Microgrid controls shall be based on the Owner approved sequence of operations. The programming for the switchgear protection devices, breaker operation and controls shall be based on normal operating conditions, utility power outage conditions, and microgrid operating modes. Programming shall include control of remote breakers and equipment as shown on sheet E-503.

B. Program sequences shall include pre-programmed operation based on real time data acquisition from local and remote devices installed on the Campus that will be installed as part of this project and other projects identified in the Scoping Documents. Data acquisition will be managed over copper and fiber private network cabling installed by this project and other projects identified in the Scoping Documents.

C. SCADA and Microgrid program sequences shall be submitted for review and approval.

D. Bench testing of the program sequences shall be performed in advance of any field programming activity to verify proper responses and operations. The test setup will include the actual installed devices including relays and controllers to simulate actual system operation.

E. Programming of protective devices with the approved power system study protection settings will be prepared by the same firm providing the operational control programming. One file will be loaded to each device in the field, complete with all programming included.

F. Refer to section 26 0573 Power System Studies and Section 26 0914 Power System SCADA for additional requirements.

3.07 TESTING

A. The Power study as listed in section 26 0573 Electrical Power System Studies is to be completed and approved prior to testing performed in section 26 0800 Electrical Testing Requirements.

B. See section 26 0800 Electrical Testing Requirements for all that is required by the testing contractor along with support by electrical contractor.

C. Work required by section 26 0800 Electrical Testing Requirements and support shall be include in the Contract bid price.

D. Provide test submittal for approval. Refer to Division 01 for additional requirements.

E. Provide test reports submittal in PDF format. Provide three (3) paper copies on a minimum of 8.5-inches by 11-inches paper size if required by Owner's Representative.

F. Contractor shall be responsible to correct and implement all corrections and retesting of equipment and cable at no additional costs to Owner.

3.08 COMMISSIONING

A. Refer to Section 26 0800, Testing Requirements, for all testing to be completed and approved prior to commissioning listed in Section 26 0801, Commissioning of Electrical Systems.

B. See to Section 26 0801, Commissioning of Electrical Systems, for system commissioning requirements.

C. The Electrical Contractor is responsible to provide assistance to the Commissioning Agent throughout the entire commissioning process to ensure that all systems are operating in a manner consistent with the Design Intent. The work is not complete until the Commissioning Agent and the Owner's Representative have signed off on the commissioned systems.

D. The Contractor shall provide all labor and required tools requested by the Commissioning Agent to complete the system commissioning work. Provide and schedule equipment Factory Representative for this work when needed.

E. Work for Contractor noted in Section 26 0801, Commissioning of Electrical Systems, along with support shall be included in the Contract bid price.

F. Commissioning Agent shall be responsible to prepare and submit the final commissioning report.

3.09 TRAINING

A. Upon completion and energization of each system provide training program and instructions to the Owner's personnel for each system that is installed as part of the Work. Refer to individual specification sections for additional requirements.

B. B. All training shall be videotaped and delivered to Owner's Representative in DVD format unless otherwise noted.

C. Coordinate the training schedule with Owner's Representative.

D. Equipment Operation & Maintenance (O&M) manuals shall be provided at least 2 weeks prior to the scheduled personnel training.

E. Contractors bid shall include the total cost for trainer's site visit and include all shipping, travel, lodging, per diem and local transportation.

3.10 RECORD DRAWINGS AND CLOSEOUT DOCUMENTATION

A. Maintain up to date record set of electrical prints on a daily basis during the course of construction, including deferred submittal drawings. Use green to indicate deletions and red to indicate additions. Use same symbols and follow as much as possible the same drafting procedures used on Contract Drawings. The prints are subject to weekly review by the Owner's Representative to ascertain that they are current. The IOR shall review the as-built drawings prior to approval of Contract progress payments. In addition to the requirements specified in Division 01, final electronic AutoCAD files for Record Drawings shall indicate at least the following:

1. Changes to raceway systems, size and location, for both exterior and interior; changes to locations of control devices; busways; distribution, changes in wire sizes, circuit designations of branch circuitry; fuse and circuit breaker size and arrangements. Changes to control, schedules, and one line drawings and details.

2. Changes on equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Approved substitutions, Contract Modifications, and actual equipment and materials installed shall be shown on the plans. Reference to RFI responses and directives alone is not acceptable.

4. All field changes shown on field markup drawings.

5. Surveyed coordinates as-built info for all underground duct banks, pullbox, handhole and vault locations added in this project.

B. Prepare closeout record documents in accordance with the requirements of this section and Division 01 Section Closeout and Procedures and Project Record Documents.

C. Provide PDF files for review of record and deferred submittal drawings by the Owner's Representative and Engineer. Contractor shall make revisions and corrections as noted to the Record Documents review.

D. After approval of record drawings, provide two full-size, hardcopy sets of As-Built Record Drawings and (2) CDs of identical electronic unlocked with all reference files in AutoCAD (.dwg) or Revit files with PDFs of As-Built drawing files and As-Built drawings of the deferred submittals. Confirm with Owner's Representative version of AutoCAD or Revit software. Each drawing sheet shall be a separate file with sheet name.

E. Provide special tools and/or spare parts as required by Division 26 specifications. Provide written proof of delivery submittal for approval.

F. Create a Project Closeout Document Reference Index for review.

G. Coordinate the requirements of all sections of Division 26 and the associated electrical drawings for the closeout requirements. Prepare electronic files in PDF format for the list of items below, but not limited to. Follow file format described in submittals, above. Arrange all electronic Product Data Sheets on Record Document CDs by component type, as listed on the approved Project Closeout Document Reference Index. Document Reference Index shall be grouped into the Closeout Document Folder under the division identified in the Project Checklist.

1. All approved submittals for all equipment and deferred submittal equipment, items and products installed in the Project compiled as one.

2. Equipment and deferred submittal equipment System Block Diagrams, Point-to-Point Wiring Diagrams, and Terminal Identification.

3. Equipment Installation manual, maintenance manual, parts lists, operation manual, programing manuals, as-built data sheets, and manufacturers test reports.

    a. The O&M manual shall include the following information for equipment as minimum:

        1) Manufacturers' names and addresses.

        2) Product catalogs, exploded views and brochures, complete with technical and performance data for all equipment, marked to indicate actual items furnished and intended use and incorporating all amendments made.

        3) As-built wiring diagrams, including single-line and three-line wiring diagrams.

        4) As-built programming and sequence of operations for programmable equipment.

        5) Provide 3 hard bound copies when required by the Owner.

        6) Provide PDF copies in the closeout documentation.

4. Provide all documentation required from the manufacturer to honor the equipment and material warranty.

5. Provide manufacturer's written warranty.

6. Include a copy of all project RFI logs with dates and the listings of issues and resolutions.
7. Include all Submittal logs with dates and final approval documentation.
8. Panel schedules.
9. Fuse data and locations.
10. GPS survey data in Microsoft Excel.
11. Include all final Testing Reports.
12. Include all full and complete copy of the approved Power Systems Study including arc flash hazard labeling.
13. Provide a letter signed by the Contractor that states that the completed electrical installation of electrical equipment, raceway, cables, is warranted for a period of 1 year from the Owner's accepted of Notice of Completion.
14. Provide a list of all special tools and spare parts that have been delivered to the Owner with the Owner's Representative signature.

H. After review of closeout documents by the Owner's Representative and Engineer Contractor shall make additions, revisions, and corrections as noted to these documents and provide updated sets. Each PDF shall have a separate PDF file for its own component and not one PDF for all items.

END OF SECTION

SECTION 26 0501 – MINOR ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that abandoned wiring and equipment serve only abandoned facilities.

B. Report discrepancies to Engineer before disturbing existing installation.

C. Beginning of demolition means Contractor accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from Owner at least 4 weeks before partially or completely disabling system.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove abandoned wiring to source of supply.

C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

E. Disconnect and remove abandoned panelboards and distribution equipment.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

H. Provide cover plates to cover holes in trenches when equipment is removed.

3.04 CLEANING AND REPAIR

A. Comply with provisions of Section 26 0500.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

END OF SECTION

SECTION 26 0505 – SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Disconnection of power to selected portions of building of structure.

B. Demolition and removal of selected electrical components.

1.02 RELATED REQUIREMENTS

A. Division 01 Section for Cutting and Patching and Division 02 Section for Demolition.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.03 APPLICABLE PUBLICATIONS

A. Environmental Protection Agency (EPA) Regulations.

1. 40 CFR 261: Identification and Listing of Hazardous Waste.
2. 40 CFR 262: Standards Applicable to Generators of Hazardous Waste.
3. 40 CFR 263: Standards Applicable to Transporters of Hazardous Waste.
4. Hazardous Waste Facilities.

B. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Regulation:

1. 29 CFR 1910.94 Subpart G, Occupational Health and Environmental Control.

C. Department of Transportation (DOT):

1. 49 CFR 178: Specifications for Packaging.

1.04 JOB CONDITIONS

A. Perform all demolition as needed to accomplish new work.

B. Do not rely solely on electrical drawings to determine extent of general construction demolition. Refer to architectural demolition plans for the exact extent of general construction demolition required by this contract.

C. This Contractor is responsible for all charges, fees etc. incurred as a result of the electrical portion of the demolition.

D. Prior to demolition or alteration of structures, the following shall be accomplished:

1. Review available record documents of the existing construction. Owner does not guarantee that existing conditions are same as those indicated in record documents.
2. Coordinate sequencing with Owner and other Contractors.
3. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.
4. Coordinate means to provide exhaust and makeup air to maintain the construction zone at an adequate negative pressure to contain all construction dust and fumes.
5. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.

6. Equipment noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time designated by the Project Manager.
7. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
8. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.
9. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.01 PREPARATION

A. Survey existing conditions and correlate with requirements indicated to determine the extent of selective demolition required.

B. Refer to demolition drawings of other trades. Where motors, control panels, and other loads that have an electrical connection are being removed, include the disconnection and removal of associated electrical feeds, circuits, and loose control equipment in this contract.

C. Protect existing work to remain in place, to be reused, or to remain property of Owner.

D. Protect existing services and utilities.

E. Disconnect electrical systems scheduled for removal.

F. Coordinate power outages with Facilities Department and the Project Manager, minimum 6 weeks prior to actual outage date.

G. Provide temporary wiring and connections and/or temporary generators to maintain existing circuits in service during demolition and construction.

H. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from Project Manager before partially or completely disabling system. Minimize outage duration to periods included in the project documents and as established by the Project Manager. Make temporary connections to maintain service to areas adjacent to work area.

3.02 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Commencement of demolition means Contractor has verified and accepted existing conditions.

B. Existing electrical equipment in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all electrical equipment released from service as a result of construction, or planned construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. All mechanical components shall be stored on site for Owner assessment. Any components not retained by the Owner shall be removed by the contractor. Properly dispose or remove from site any items not retained by Owner.

C. Any existing services or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary power connections, lighting, controls, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any conduit, wiring, fixtures, or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation, provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.

D. Verify circuiting arrangements are as shown on Drawings.

E. Verify that abandoned wiring and equipment serve only abandoned facilities.

F. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to Architect before disturbing existing installation.

G. Prior to demolition, verify the voltage phase sequence at each building or load that will be reconnected after demolition activity. Verify that all loads are re-energized with the correct, existing, phase sequence after any circuit modifications are completed.

H. De-energize, disconnect, demolish, and remove electrical systems, equipment, raceways, wiring, and components indicated to be removed.

I. Conduit to Be Removed: Remove portion of piping indicated or specified to be removed. In general, all above grade empty raceways and associated supporting devices shall be removed back to nearest active junction box, panelboard, switchboard, panel cabinet, or other similar enclosure.

J. Conductors to be Removed: Unless specifically stated elsewhere, all un-terminated conductors shall be de-energized, and all de-energized conductors shall be removed back to source.

K. Equipment to be Removed, Including all Overhead 12kV system components, Panelboards and Distribution Equipment: De-energize, disconnect associated raceways and wiring, and remove equipment.

L. Equipment to Be Removed and Reinstalled: De-energize, disconnect associated raceways and wiring, and remove equipment. Clean equipment and store where appropriate, reinstall, reconnect, and make equipment operational. Test equipment and associated components in accordance with the appropriate specification section.

M. Equipment to Be Removed and Salvaged: De-energize, disconnect associated raceways and wiring, and move equipment to on site storage area as designated by the Owner.

N. Any unused conduit openings in junction boxes, panelboards, switchboards, panel cabinets, pull boxes, or other similar enclosures shall be covered in a code approved manner.

O. Update any pole numbers, equipment numbers, electrical circuit directories or breaker identification nameplates to reflect changes in the status of overcurrent devices resulting from demolition.

P. Disconnect and remove abandoned luminaires. Remove brackets, stands, hangers, and other accessories.

Q. Contractor shall check all oil filled q equipment including transformers, capacitors, ballasts of light fixtures, and other oil filled devices removed from service. If any equipment or ballasts contain PCB's those ballasts shall be stored on site in containers and in a manner approved by local authorities and the Environmental Protection Agency. The contractor shall not be responsible for disposal of equipment and ballasts that contain PCB's

R. Notify Architect of location and extent of existing piping, conduit, OR equipment that interferes with demolition activity and new construction. In coordination with and with approval of Architect, relocate conduit and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned conduit and equipment as directed by Architect. Dispose of or store items as requested by Architect.

S. Outlet boxes being abandoned in existing walls in remodeled areas shall have opening patched to match existing wall finish. Blank covers are not acceptable.

T. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

U. Maintain continuity of circuits that remain in service.

V. During the demolition and alterations, the fire alarm system, exit lighting and corridor life safety lighting shall remain active.

W. Existing conduit and wiring in remodeled area that is not being removed, but which will be in conflict with new HVAC duct work being installed, shall be rerouted as required.

X. This Contractor shall provide required additional support for existing conduit in remodeled area that is not being removed and is not properly supported in accordance with NEC requirements.

Y. When existing ductwork, piping, or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.

Z. Remove existing installations including low voltage communication and signal systems (Fire Alarm, Nurse Call, Security, etc.).

3.03 CLEANING AND REPAIR

A. Clean existing materials and equipment which remain or are to be reused. Report damage or defects to Architect

B. Existing Panelboards: Clean exposed surfaces and check tightness electrical connections. Provide closure plates for vacant positions.

C. If equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. Repair adjacent construction and finishes damage during demolition and extension work.

E. Luminaires: Clean existing luminaires shown to be reused. Use mild detergent to clean interior surfaces and visible exterior surfaces; rinse with clean water and wipe dry. Replace lamps. Energize fixtures. Notify Architect of fixtures with faulty components.

END OF SECTION

SECTION 26 0513 – MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.02 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories. Contractor shall furnish cable manufacturer's catalog cut sheets and written statements from the manufacturer for the specific cable to be furnished that shall include the following information:

1. Conductor size, and stranding, ampacity as stated below.
2. Type and thickness of the semi-conducting shield.
3. Type and thickness of insulation.
4. Type and thickness of insulation shield.
5. Type and thickness of jacket.
6. Diameter of the insulated, shielded cable and variations from the average O.D. due to production.
7. Diameter of the single cable including the jacket.
8. Diameter over the insulation for single cable.
9. Recommended minimum bending radius, single conductor.
10. Cable weight per 1000 feet.
11. Manufacturer's recommendation for:
    a. Maximum pulling tension with conductor pulling eye and cable grip.
    b. Maximum sidewall pressure.
12. Cable pulling tension calculations for each cable run shall be submitted with the submittal for review and approval.
13. Cable manufacturer's name and location of plant at which cable will be produced.
14. Manufacturer's warranty for cable offered.

C. Qualification Data: For testing agency and splicing/termination personnel.

D. Material Certificates: For each cable and accessory type, signed by manufacturers, certifying that cables comply with requirements specified in Part 2.06, "Source Quality Control."

E. Field quality-control test reports.

F. Warranties: In accordance with Section 3.03 of this Specification.

1.03 QUALITY ASSURANCE

A. Only experienced personnel shall be allowed to handle the installation, splicing, and terminations of high voltage cable.

B. Experience records of cable splicers/handlers shall include educational or special instruction courses attended for splicing and any certifications issued by cable manufacturers. Splicing experience shall include a minimum of 5 years of experience as a journeyman cable splicer, with dates and jobs listed. No one shall be permitted to splice or terminate medium voltage cable prior to Owner having reviewed the qualifications of the cable splicer. Contractor shall provide Owner, in writing, compliance with these Specifications. All electricians including cable splicers shall have general electrician certification required by the California Division of Apprenticeship Standards.

C. Testing Agency Qualifications and Procedures: Refer to specification Section 26 0800, Electrical Testing Requirements.

D. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2 and CEC.

1.04 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary power and utility services according to requirements indicated:

1. Notify the Owner at least 14 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner Representative written permission.
3. Submit temporary power plan details.
4. Submit a switching procedure with lock-out/tag-out provisions identified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cables
    a. Okonite Company (The).
    b. Southwire Company.
    c. Kerite Co. (The).
    d. Or equal.
2. Cable Splicing and Terminating Products and Accessories
    a. Thomas & Betts/Elastimold
    b. Cooper
    c. Raychem Corp.; TE Connectivity
    d. 3M Company; Electronics Division.
    e. Or equal.

B. Or Equal: Where products are specified by manufacturers name and accompanied by the term "or equal", comply with provisions in Division 01 for product substitutions. Specific procedures must be followed before use of a product or manufacturer not listed in the Project documents.

2.02 CABLES

A. Cable Type: MV-105.

B. Conductor: Copper.

C. Conductor Stranding: Compact round, concentric lay, stranded in accordance with ASTM B-496.

D. Conductor Insulation: Ethylene-propylene rubber complying with ANSI/ICEA S-93-639; NEMA S-97-682.

1. Voltage Rating: 15kV, except where otherwise specified.

2. Insulation Thickness: 133 percent insulation level, except where otherwise specified.

E. Shielding: Copper tape helically applied over semi conducting insulation shield with a 25% overlap.

F. Cable Jacket: Sunlight-resistant PVC.

G. The cable furnished under these Specifications shall be suitable for installation in underground ducts, conduits, and conduit risers (plastic, steel, or concrete).

H. The cable shall be suitable for operating both in wet and dry locations and in installations with alternate wet and dry conditions. Under wet conditions, alkaline liquid may be present.

2.03 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 386; type as recommended by cable or splicing kit manufacturer for the application.

B. 600-Amp Elbow Connectors, 15kV voltage rating.

C. No hand-taped splices are allowed unless specifically shown on plans.

2.04 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: 600A T-body Elbows and 200-Amp Loadbreak Elbows, 15kV voltage rating, Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.

2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

3. Class 1 Terminations, Indoors: Kit with stress-relief tube, no tracking insulator tube, shield ground strap, compression-type connector, and end seal.

2.05 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3-inch-thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2-inch wide.

2.06 SOURCE QUALITY CONTROL

A. Test and inspect cables according to NEMA WC 8 before shipping.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cables according to the latest IEEE 576.

B. Protect cable from damage while stored and during installation. Protect uninstalled and installed cable from moisture.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions, minimum bending radius and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation. Do not use oil, grease, graphite, or similar substances.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable. Pulling of conductors in raceways shall be done with an approved cable pulling machine. Other methods such as using vehicles and block and tackle to install conductors are not acceptable.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 26 0500 and 26 0529.

F. Install detectable warning tape above cables per duct details on plans.

G. Install cable splices at pull points and elsewhere as indicated; use standard kits.

H. Cut the cable at manhole or pullbox where the splice is to be made, leaving enough extra length to wrap manhole with one complete loop of cable except in manholes HMH-703 and HMH-704. Cable loop shall have a radius that is larger than the cable minimum bending radius.

I. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. Arc proof cables in manholes, vaults, and cable trench. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.

2. Wrap metallic cable components with 10-mil pipe-wrapping tape.

3. Smooth surface contours with electrical insulation putty.

4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.

5. Band arc-proofing tape with 1-inch- wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.

J. Seal around cables passing through fire-rated elements using a firestop system approved by the authority having jurisdiction.

K. Apply fireproofing tape in half-lapped wrapping. Extend fireproofing one inch into duct.

L. Include separate ground conductor with feeders.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

N. Identify cables according to Section 26 0553.

O. Seal outdoor and indoor conduits with a removable material such as Hydra-Seal S-60, or equal.

3.02 FIELD QUALITY CONTROL

A. Thoroughly clean all work areas of debris.

B. Obtain Inspector of Record and Engineer's final inspection and approval prior to energization.

C. Install all cable identification tags, fire tape, and duct sealant.

D. Provide all cable supports and bracing in termination sections.

3.03 WARRANTIES

A. Cable furnished under these Specifications shall be guaranteed against defective materials and workmanship for a period not less than 40 years from date of initial energization of system and shall include labor and travel time for necessary repairs at job site.

END OF SECTION

SECTION 26 0519 – LOW-VOLTAGE ELECTRIC POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Underground feeder and branch-circuit cable.

C. Wiring connectors.

D. Electrical tape.

E. Heat shrink tubing.

F. Wire pulling lubricant.

G. Cable ties.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0501 - Minor Electrical Demolition.

C. Section 26 0526 - Grounding and Bonding for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

G. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); 2007.

H. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.

I. CEC - California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

J. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

K. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

L. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

M. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

N. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

O. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables; Current Edition, Including All Revisions.

P. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and allowable space for wire bends and terminations.

2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.

3. Notify Engineer and Owner of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

A. Conform to requirements of CEC.

PART 2 - PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by CEC and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of CEC.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductor Material

1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.

2. Tinned Copper Conductors: Comply with ASTM B33.

H. Conductor Color Coding

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.

2. Color Coding Method: Integrally colored insulation.

3. Color Code:

a. 480Y/277 V, 3 Phase, 4 Wire System:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

4) Neutral/Grounded: Gray.

b. 208Y/120 V, 3 Phase, 4 Wire System:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

4) Neutral/Grounded: White.

c. 240/120 V, 1 Phase, 3 Wire System:

1) Phase A: Black.

2) Phase B: Red.

3) Neutral/Grounded: White.

d. DC, 2 Wire Systems

1) Positive: Red

2) Negative: Black

e. Equipment Ground, All Systems: Green.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding

1. Feeders and Branch Circuits:

a. Size 10 AWG and Smaller: Solid or Stranded Refer to Drawings for specific applications.

b. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation

1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

2.04 UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE

A. Description: CEC, Type UF multiple-conductor cable listed and labeled as complying with UL 493, Type UF-B.

B. Provide equipment grounding conductor unless otherwise indicated.

C. Conductor Stranding

1. Size 10 AWG and Smaller: Solid.

2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

2.05 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

1. Indoor, Size 10 AWG and Smaller:

a. Listed twist-on wire connectors, suitable for size and quantity of conductors to be spliced.

b. Acceptable Manufacturers: 3M, Ideal Industries, or approved equal.

2. Outdoor: Size 10 AWG and Smaller:

a. Silicone filled sealable waterproof connectors, acceptable for wet locations.

b. Acceptable Manufacturers: 3M, King Innovation, Ideal Industries, or approved equal.

3. Size 8 AWG or Larger:

a. Use insulated tap block connector with mechanical lugs to join conductors

b. Acceptable Manufacturers: Tork/NSI or approved equal.

4. Terminate conductors on padmount transformer secondary spade terminals with compression connectors.

a. Acceptable Manufacturers: Ideal Industries, Thomas and Betts, or approved equal.

2.06 WIRING ACCESSORIES

A. Electrical Tape

1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F

(-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

3. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

D. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with CEC.

D. Verify that field measurements are as shown on the drawings.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.

C. Install underground feeder and branch-circuit cable (Type UF-B) in accordance with NECA 121.

D. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.

2. Pull all conductors and cables together into raceway at same time.

3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.

4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

E. Paralleled Conductors: Install conductors of the same length and type. Terminate all conductors in the same manner.

F. Secure and support conductors and cables in accordance with CEC using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

G. Terminate cables using suitable fittings.

H. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with CEC.

K. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.

2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.

3. Do not remove conductor strands to facilitate insertion into connector.

4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

M. Insulate ends of spare conductors using vinyl insulating electrical tape.

N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION

SECTION 26 0526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Ground access wells.

G. Telecommunications/signaling systems grounding.

1.02 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26 0553 - Identification for Electrical Systems.

C. Section 26 0800 – Electrical Testing Requirements.

1.03 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

B. IEEE Standard 80 - Guide for Safety in AC Substation Grounding.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction.

D. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.

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

F. CEC – California Electric Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

G. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

H. IEEE Standard 141 - Recommended Practice for Electrical Power Distribution for Industrial Plants.

I. IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components, listing all physical and electrical characteristics and ratings. Indicate NRTL listing and labeling compliance to listed standards. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.

C. Shop Drawings

1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.

D. Manufacturer's installation Instructions.

E. Project Record Documents: Record actual locations of grounding electrode system components and connections. The location of each ground rod, ground rod assembly, and other grounding electrodes shall be identified and record of ground resistance tests.

F. Measured resistance values shall be submitted for review.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Verify exact locations of underground metal water service pipe entrances to building.

2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.

3. Notify Owner’s Representative of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.06 QUALITY ASSURANCE

A. Conform to requirements of CEC.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum seven years documented experience.

C. Product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by CEC, PG&E, and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with CEC but not less than applicable minimum size requirements specified. Where Project Documents call for a larger size than mandated by CEC, the Project Documents shall prevail.

E. Provide and install copper ground bar minimum 1/4 by 4 by 14 inches in all electrical rooms.

F. Ground conductors shall have green insulation. Where continuous color-coded conductors are not commercially available, provide a minimum 2 inch green color tape band in direction of cable path, non-aging, plastic tape in accordance with CEC. Color band to be within 2 inches of the cable connector or termination.

G. Bonding Pigtails: Insulated copper conductor, identified green, sized per code, and provided with termination screw or lug. Provide solid conductors for #10 AWG or smaller and stranded conductors for #8 AWG or larger.

H. Grounding System Resistance

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Owner's Representative. Precipitation within the previous 48 hours does not constitute normally dry conditions.

2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

I. Grounding Electrode System

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.

a. Provide continuous grounding electrode conductors without splice or joint, except where indicated on Drawings.

b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

2. Metal Underground Water Pipe(s)

a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.

b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.

c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Concrete-Encased Electrode

a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of bare copper conductor not smaller than 4/0 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with CEC.

4. Ground Ring

a. Where indicated on drawings provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 4/0 AWG in direct contact with earth, installed at a depth of not less than 30 inches.

b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.

c. Provide connection from ground ring conductor to the building ground rod electrodes.

5. Ground Rod Electrode(s)

a. Provide single electrode unless otherwise indicated or required.

b. Space electrodes not less than 10 feet from each other and any other ground electrode.

c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.

d. If ground rod resistance is over 25 ohms install another ground rod. Install additional rods if project requires a lower ground resistance below 25 ohms.

e. Provide ground enhancement material around electrode where indicated.

f. Provide ground access well for each electrode.

6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in CEC. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.

a. Ground Bar Size: ¼” x 4” x 14” unless otherwise indicated or required.

b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.

c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

d. Ground Bar Mounting Wall Standoff: 3 inches unless otherwise indicated.

J. Service-Supplied System Grounding

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.

2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

K. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits

1. Provide grounding electrode system for each separate building or structure.

2. Provide equipment grounding conductor routed with supply conductors.

3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.

4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

L. Separately Derived System Grounding

1. Separately derived systems include, but are not limited to:

   a. Transformers (except autotransformers such as buck-boost transformers).

   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.

   c. Generators, when neutral is switched in the transfer switch.

2. Connect the grounding bonding of the separately derived system to the electrical room ground bar.

3. Provide bonding jumper from nearest metal building frame to electrical room ground bar.

4. Provide bonding jumper from grounding electrode to electrical room ground bar.

5. Provide bonding jumper from nearest water piping in the area served by the derived system to electrical room ground bar.

6. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with CEC.

7. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.

8. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

M. Bonding and Equipment Grounding

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with CEC.

2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.

3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with CEC.

4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

7. Provide bonding for interior metal piping systems in accordance with CEC. This includes, but is not limited to:

   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.

   b. Metal gas piping.

   c. Metal process piping.

8. Provide bonding for interior metal air ducts.

9. Provide bonding for metal building frame.

10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.

11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with CEC.

12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with CEC and NFPA 99.

N. Communications Systems Grounding and Bonding

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with CEC.

2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.

   a. Bonding Jumper Size: 4/0.

   b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.

   c. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.

   d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

   e. Ground Bar Mounting Wall Standoff: 3 inches unless otherwise indicated.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements

1. Provide products listed, classified, and labeled as suitable for the purpose intended.

2. Provide products listed and labeled as complying with UL 467 where applicable.

3. Green THWN insulated copper wire where commercially available.

B. Conductors for Grounding and Bonding, in Addition to other Requirements of this spec:

1. Use insulated copper conductors unless otherwise indicated.

   a. Exceptions

      1) Use 4/0 bare copper conductors where installed underground in direct contact with earth.

2) Use bare copper conductors where directly encased in concrete (not in raceway).

2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gage of specified conductors.

C. Connectors for Grounding and Bonding

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.

a. Exceptions

1) Use mechanical connectors for connections to electrodes at ground access wells.

3. Unless otherwise indicated, use 2-hole lug compression connectors, or exothermic welded connections for accessible connections.

a. Exceptions

1) Use exothermic welded connections for connections to metal building frame if permitted to do so on structural drawings. Use steel tap or hole that was factory provided otherwise use structural grounding clamp without drilling into the steel.

2) Ground connections inside 1200 amp or less rated equipment may also use 1 hole mechanical or 1 hole lug compression connectors.

3) For water pipes use mechanical clamp of OZ/Gedney G-200B series or equal.

4) For making water pipes of continuous grounding use mechanical clamp of OZ/Gedney BJ series or equal

4. Manufacturers - Mechanical and Compression Connectors

a. Advanced Lightning Technology (ALT).

b. Burndy LLC.

c. Harger Lightning & Grounding.

d. Thomas & Betts Corporation.

e. OZ/Gedney.

5. Manufacturers - Exothermic Welded Connections

a. Burndy LLC.

b. Cadweld, a brand of Erico International Corporation.

c. ThermOweld, a brand of Continental Industries, Inc.

D. Ground Bars

1. Description: Copper rectangular ground bars with mounting brackets and insulators. Mounted on walls in locations shown, on insulating standoffs, 18" above finished floor unless otherwise noted.

2. Size: 14” wide by 4" high by 1/4" thick unless otherwise indicated or required.

3. Ground Bar Mounting Wall Standoff: 3 inches unless otherwise indicated.
4. Provide UL approved two-hole lugs for connecting grounding system cables. Attach lugs to bus with bolts and washers. Torque all connections.
5. Holes for Connections: As indicated or as required for connections to be made. Provide 6 spare lug spaces unless otherwise noted.
6. Manufacturers for lugs
    a. Burndy.
    b. Thomas & Betts.
    c. Or Equal

E. Ground Rod Electrodes
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel with heavy uniform copper coating.
3. Size: 3/4-inch diameter by 10 feet length, unless otherwise indicated.
4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.
5. Manufacturers
    a. Advanced Lightning Technology (ALT).
    b. Erico International Corporation.
    c. Galvan Industries, Inc.
    d. Harger Lightning & Grounding.
    e. Blackburn.

F. Ground Access Wells
1. Description: Pre-cast concrete open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
    a. Round Wells: Not less than 8 inches in diameter.
    b. Rectangular Wells: Not less than 12 by 12 inches.
3. Depth: As required, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers
    a. Brooks Products
    b. Jensen Precast.
    c. Amorcast
    d. Or Equal.

G. Oxide Inhibiting Compound.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as shown on the drawings.

C. Verify that conditions are satisfactory for installation prior to starting work.

D. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1 and CEC.

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45-degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with CEC.

1. Outdoor Installations: Unless otherwise indicated, install with top of rod 12 inches below finished grade.

2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

D. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.

2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.

3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 0553 Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. Test in accordance with Section 26 0800 Electrical Testing Requirements

B. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

C. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

D. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 26 0529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 26 0534 - Conduit.

B. Section 26 0537 - Boxes.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. CEC - California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.

2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-metallic cable racking systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

1.06 QUALITY ASSURANCE

A. Comply with CEC.

B. Comply with CBC.

PART 2 - PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.

2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

3. Do not use products for applications other than as permitted by CEC and product listing.

4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.

a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.

2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

1. Comply with MFMA-4.

2. All strut framing systems installed outdoors shall be hot-dipped galvanized steel. All fasteners shall be galvanized steel suitable for the hot dipped galvanized steel materials.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

F. Rack Supports in Manholes

1. Install nonmetallic cable racking system with stanchion and arms.

2. Cable rack shall be constructed of nonmetallic UL Listed Glass Reinforced Polymer.

G. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.

3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

4. Use nonmetallic UL Listed glass reinforced polymer stanchions and racking arms for cable racking within manholes.

5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Secure fasteners according to manufacturer's recommended torque settings.

I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 0534 - CONDUIT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Intermediate Metal Conduit (IMC).

C. Flexible Metal Conduit (FMC).

D. Liquidtight flexible metal conduit (LFMC).

E. Electrical metallic tubing (EMT)

F. Rigid polyvinyl chloride (PVC) conduit.

G. Liquidtight flexible nonmetallic conduit (LFNC).

H. PVC-coated galvanized steel rigid metal conduit (P-RMC).

I. Extra Heavy wall Fiberglass conduit (RTRC XHW).

J. Conduit fittings.

K. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0500 – Common Work Results for Electrical.

C. Section 26 0526 - Grounding and Bonding for Electrical Systems.

D. Section 26 0529 - Hangers and Supports for Electrical Systems.

E. Section 26 0537 – Boxes.

F. Section 26 0553 – Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).

B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT).

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC).

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.

E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association.

F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association.

G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

H. NEMA RN 1 – Polyvinyl-Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.

I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2013.

J. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2015.

K. CEC – California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

L. UL 2 – Flexible Metal Conduit; Current Edition, Including All Revisions.

M. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

N. UL 360 – Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

P. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

Q. UL 797 – Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

R. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

S. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

T. UL 1684 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

U. UL 1684A –Supplemental Requirements for Extra Heavy Wall Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide for each type and size of conduit, liquid tight flexible, conduit bodies, fittings, showing characteristics and dimensions.

C. Shop drawings of any fire rated assembly and roof penetrations: provide proposed locations of penetrations and methods for sealing.

D. Cable pulling tension calculations:

1. Submit cable pulling tension calculations as indicated on the drawings.

2. Submit cable pulling tension calculations for all cables rated above 600 volts.

E. Structural Engineers stamped and approved drawings for conduits not attached to building walls, not using C-clamps to building I beams and/or trapeze as noted this specification.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop, and as required by code.

2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

3. Verify exact conduit termination locations required for boxes, enclosures, and equipment that is installed for this project or is existing and to be interconnected for this project.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points, and cable pulling tension calculations are approved.

1.06 QUALITY ASSURANCE

A. Conform to requirements of CEC.

B. Product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Inspect for damage and replace as needed.

D. Protect conduit that is not sunlight and ultra-violet resistant from sunlight.

PART 2 - PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Conduit and associated fittings shall only be used for applications as permitted by CEC and product listing.

B. The minimum size of conduit shall be ¾ inch unless otherwise specified.

C. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

D. Underground:

1. Under Slab on Grade (within structure slabs only where approved by Structural Engineer): Use rigid PVC conduit.
2. Exterior, Direct-Buried: Use rigid PVC conduit.
3. Exterior, Embedded within Concrete: Use rigid PVC conduit.
4. Transition to galvanized steel rigid metal conduit where emerging from underground.

E. Embedded Within Concrete Walls:

1. Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal (P-RMC), or rigid PVC conduit.
2. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

F. Concealed Within Masonry: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal (P-RMC), or electrical metallic tubing (EMT).

G. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

H. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

I. Exposed, Interior, Not Subject to Physical Damage

1. Use galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC). or electrical metallic tubing (EMT).
2. Locations Not subject to Physical Damage shall include electrical rooms, control rooms, data / telephone rooms, and offices, and protected locations in Processing plant rooms, industrial process, and utilization equipment where conduits are 9 feet above finished grade.

J. Exposed, Interior, Subject to Physical Damage

1. Use galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC).
2. Locations subject to Physical Damage areas shall include, but not limited to processing plant rooms, industrial process, and utilization equipment. Conduits for these rooms, 0 to 9 feet above finished grade, or where exposed to damage due to operations and maintenance activity, are considered to be the subject to physical damage.

K. Exposed, Exterior, outdoor areas: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal (P-RMC).

L. Exposed, Exterior, in continuous wet and/or corrosive areas such as Cooling Towers:

1. Use Extra Heavy Wall Fiberglass conduit or rigid PVC schedule 80 conduit and non-metallic fittings and boxes.
2. Locations subject to continuous damp/wet and/or corrosive areas shall extend to 40 feet of surrounding area.

M. Concealed, Exterior, Not Embedded in Concrete or in Contact with Earth: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal (P-RMC).

N. Connections to Luminaries above Accessible Ceilings: Use flexible metal conduit (FMC).

O. Connections to Vibrating Equipment

1. Dry and outdoor locations: Use liquidtight flexible metallic conduit (LFMC).
2. Continues damp/wet or Corrosive Locations: Use Liquidtight flexible nonmetallic conduit (LFNC).
3. Maximum Length of flexible connection: 6 feet (1.8 m) unless otherwise indicated.

4. Minimum Length of flexible connection:
    a. Conduits of 1 ¼ inches or less: 14 inches.
    b. Conduits of 2 ½ to 2 inches: 18 inches.
    c. Conduits of 4 to 3 inches: 22 inches
5. Vibrating equipment includes but not limited to:
    a. Transformers
    b. Motors
    c. Pressure, flow, etc. sensors attached to plumbing or HVAC equipment

2.02 CONDUIT APPLICATIONS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from damage and corrosion, and integrity and interior shape is verified by pulling a mandrel through them.

B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Exceptions to the minimum conduit size of ¾ inch is ½ inch for flex connections to process sensors and lighting fixtures or as noted on drawings.

E. Where conduit size is not indicated, size to comply with CEC but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: CEC, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings
    1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
    2. Material: Use steel or malleable iron.
    3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: CEC, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings
    1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
    2. Material: Use steel or malleable iron.
    3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (P-RMC)

A. Description: CEC, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

C. Interior Coating: Urethane, minimum thickness of 2 mil.

D. PVC-Coated Fittings

1. Manufacture: Same as manufacture of PVC-coated conduit to be installed.

2. Material: Use steel or malleable iron.

3. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

4. Interior Coating: Urethane, minimum thickness of 2 mil.

E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.06 FLEXIBLE METAL CONDUIT (FMC)

A. Description: CEC, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

B. Fittings

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B,

2. Material: Use steel or malleable iron.

2.07 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: CEC, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2. Material: Use steel or malleable iron.

2.08 ELECTRICAL METALLIC TUBING (EMT)

A. Description: CEC, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2. Material: Use steel or malleable iron.

3. Connectors and Couplings: Use compression (gland).

a. Do not use indenter type or set-screw connectors or couplings.

2.09 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: CEC, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings

1. Manufacturer: Same as manufacturer of conduit to be connected.

2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

C. Paint PVC conduits and fittings exposed to sun light. Paint to be rated for outside usage and color shall be approved by the engineer before application.

2.10 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Description: CEC, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

B. Fittings

1. Manufacturer: Same as manufacturer of conduit to be connected.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.11 FIBERGLASS CONDUIT

A. Description: CEC, Type “XW” Extra Heavy Wall Epoxy Fiberglass conduit (RTRC XHW), XW UL 1684A listed and labeled as for use as heavy wall reinforced conduit. Rated for use with conductors rated 90 degrees C and UV restraint.

1. Conduit and fittings shall be manufactured in accordance with the following specifications:

a. UL-1684-UL-1684A, UL Guide DZKT

b. Physical Properties:

1) Glass Content, 68% ± 3%; API 15LR

2) Specific Gravity; ASTM D792

3) Barcol Hardness; ASTM D2583

4) Water Absorption; ASTM D570

5) UV Resistance; CSA C22.2 #221.3/UL-1684

2. All RTRC XHW Conduits and Associated Fittings shall meet the following Specifications:

Size (in.)	Wall (in.)	Weight (lbs./ft.)	Failure Load (ASTM D2412) (lbs./ft.)	Impact (ASTM D2444) (lbs./ft.)	Moment of Inertia (in.)
2	.250	1.49	12,000	120	1.132
3	.250	2.16	11,000	160	3.390
4	.250	2.82	10,000	200	7.562
5	.250	3.48	8,000	240	14.238
6	.250	4.14	7,000	280	24.007

3. Extra Heavy Wall Epoxy Fiberglass Conduit and Fittings Type RTRC XHW shall manufactured and supplied by FRE Composites Inc., or approved equal.

B. Fittings

1. Manufacturer: Same as manufacturer of conduit to be connected.

2. Description: Fittings Extra Heavy Wall Epoxy Fiberglass, XW UL 1684A listed and labeled. Material to match conduit and made of same process as the conduit.

3. Connection: Straight socket with Fiberglass epoxy adhesive approved by the manufacture. Threaded joints not allowed.

2.12 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Use pull tape of Polyaramid Kevlar in all underground PVC conduits for pulling in cables. Pulling with pull rope or other similar items is not allowed. Pull tape with footage markers and minimum strength 1250 pound-force. Minimum strength will be selected based on contractor's cable pulling calculations.

1. Tape to be minimum ¼ inch size for conduit sizes ¾ to 1 inch.

2. Tape to be minimum 3/8 inch size for conduit sizes 1 ¼ to 1 ½ inches.

3. Tape to be minimum ½ inch size for conduit sizes 2 to 2 ½ inches.

4. Tape to be minimum 5/8 inch size for conduit sizes 3 to 4 inches.

5. Tape to be minimum ¾ inch size for conduit sizes 5 to 6 inches.

E. Provide continuous-fiber polyline/nylon cord in spare conduits with average breaking strength of not less than 200 pound-force.

F. Use compressible rubber modular sealing products (i.e. Link Seal) for all core drilled conduit penetrations through concrete or masonry to provide a watertight seal for all under grade locations.

G. Use expandable mechanical conduit duct plug seals for spare underground conduits in manholes, pullboxes, and below grade conduit entries into equipment and boxes. Plug to be of high impact plastic components with durable elastic gaskets with pull rope tie device to allow the securing pull rope on back side of seal. Not required if both ends of the conduit are terminated inside a fully enclosed building and at the end terminating inside an enclosure.

H. Expandable polyurethane foam products (i.e. Semco PR-821 by PRC-DeSoto) with density of 7 to 8 pounds per cubic foot or duct sealing compound to seal insides of underground conduits with cables entering manholes, pullboxes, and equipment. Seal against intrusion of water, gases, or critters. Check drawings to insure which type, polyurethane or sealing compound is noted as acceptable. Not required if both ends of the conduit are terminated inside a fully enclosed building.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field dimensions and measurements are as shown on drawings.

B. Verify scale and dimensions when provided.

C. Verify routing and termination locations of conduit prior to rough-in.

D. Verify that mounting surfaces are ready to receive conduits.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install intermediate metal conduit (IMC) in accordance with NECA 101.

E. Install PVC-coated galvanized steel rigid metal conduit (P-RMC) using only tools approved by the manufacture.

F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

G. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

H. Use suitable caps to protect installed conduits against entrance of dirt and moister. Install caps on end of all stubbed out underground conduits.

I. Conduit Routing

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Unless otherwise approved, do not route conduits exposed:
    a. Across floors.
    b. Across roofs.
    c. Across top of parapet walls.
    d. across building exterior surfaces.
4. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
5. Arrange conduit to maintain adequate headroom, clearances, and access.
6. Combining conduit runs of conduit homeruns for any different systems from those shown on the drawings is not acceptable.
7. It shall be unacceptable to combine circuits, conduits, cables, pull boxes, or junction boxes of extra low voltage systems and low voltage systems. No combining of communications systems with power systems will be permitted, unless the combination is necessary for termination within an equipment assembly.
8. Arrange conduit to provide no more than the equivalent of three 90 degree bends between pull points.

9. Arrange conduit to provide no more than 150 feet between pull points unless otherwise shown for underground duct banks.
10. Route conduits above water and drain piping inside of buildings where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces exceeding 104 degrees F.
14. Group parallel conduits in the same area together on a common rack.
15. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations.

J. Conduit Support

1. Secure and support conduits in accordance with CEC and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent supports that are attached to the building structure. Do not provide support from piping, ductwork, ceiling grid, or other systems.
3. Use conduit strap to support single surface-mounted conduit.
4. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
5. Use conduit clamp to support single conduit from beam clamp.
6. Use of wire for support of conduits is not permitted. Remove temporary supports.
7. The use of trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits require the submittal of structural drawings stamped and approved.
8. Provide structural drawings and details stamped and approved for all conduits that are not supported from walls or not supported from building I beams using beam C-clamps.
9. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
10. Non-metal conduit couplings and expansion joints shall be located no closer than 12-inches from support hangers.

K. Connections and Terminations

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Where spare conduits stub up thru floors and not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor, unless otherwise noted.

7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.

8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

9. Provide bell end bushings for conduit entries into underground manholes, pullboxes, and terminating inside equipment from underground.

L. Penetrations

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.

2. Make penetrations perpendicular to surfaces unless otherwise indicated.

3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.

4. Make penetrations through floors water-tight with non-hardening sealant even though concealed within wall or furred space.

5. Make penetrations through any damp-proofed/water-proofed surfaces damp-proof/waterproof by appropriate means to maintain integrity of system penetrated.

6. Seal around penetration with acoustical material to maintain the integrity of acoustical rating where occurs.

7. Conceal bends for conduit risers emerging above ground.

8. Seal interior of conduits entering the building or equipment from underground at first accessible point to prevent entry of moisture and gases.

9. Seal interior of underground conduits entering manholes and pull boxes to prevent entry of moisture, gases, and critters.

10. Provide modular sealing where conduits penetrate exterior wall below grade.

11. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.

12. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.

13. Pack space between conduit, sleeve in rated walls with non-combustible materials. Install fire marshal approved firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

M. Concrete Encasement Where Required:

1. Secure conduits to conduit racks and supports to prevent floating or movement during pouring of concrete.

2. Minimum concrete of 3 inches on all sides unless otherwise indicated.

3. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length.

N. Conduit Movement Provisions:

1. Where conduits are subject to flexure from seismic earth movement, provide (expansion/contraction, angular misalignment, and parallel deflection) fittings and/or flexible conduit assembly consisting of a combination of approved fittings and conduit to prevent damage to enclosed conductors, conduits, or connected equipment. Approved assembly shall meet total movement requirements provided by the structural engineer or as indicated on the drawings. The locations include, but is not limited to:

   a. Where conduits cross structural joints intended for expansion, contraction, or deflection.

   b. Where conduits cross between free standing buildings or seismic gap.

   c. Where conduits are subject to seismic earth movement.

2. Where conduits are subject to thermal movement, provide (expansion/contraction, angular misalignment, and parallel deflection) fittings and/or flexible conduit assembly consisting of a combination of approved fittings and conduit to prevent damage to enclosed conductors, conduits, or connected equipment. The locations include, but not limited to:

   a. Where conduits are outside and straight runs longer than 150 feet.

   b. Where shown or noted on the drawings.

   c. As required by the conduit manufacturer.

O. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits of a long run of 100 feet or more outside pass from outdoors into conditioned interior spaces. Sealing fitting also with drain.

2. Where conduits of a long run of 200 feet or more outside and then go down and pass into a building or underground. Sealing fitting also with drain.

3. Where conduits penetrate coolers or freezers.

P. Provide pull string in all empty conduits and in conduits where conductors are to be installed by others. Leave minimum slack of 18 inches at each end. Add tag at each end identifying opposite end location.

Q. Provide grounding and bonding in accordance with Section 26 0526.

R. Identify conduits in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by the manufacture. Replace components that exhibit signs of corrosion.

B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter prior to conductor installation.

END OF SECTION

SECTION 26 0535 – SURFACE RACEWAYS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wireways.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. CEC – California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

D. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.

C. Shop Drawings:

1. Wireways: Provide proposed locations for usage.

1.05 QUALITY ASSURANCE

A. Conform to requirements of CEC.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.

C. Product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 RACEWAY REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use raceways for applications other than as permitted by CEC and product listing.

2.02 WIREWAYS

A. Manufacturers

1. Cooper B-Line, a division of Eaton: www.cooperindustries.com.
2. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com.
3. Schneider Electric; Square D Products: www.schneider-electric.us.
4. Or approved equal.

B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.

C. Wireway Type, Unless Otherwise Indicated

1. Indoor Clean, Dry Locations: NEMA 250, Type 1, painted steel with screw-cover or quick release latch hinged cover.
2. Outdoor Locations: NEMA 250, Type 3R, painted steel with screw-cover.

D. Finish for Painted Steel Wireways: Manufacturer's standard grey unless otherwise indicated.

E. Minimum Wireway Size: 4 by 4 inches unless otherwise indicated.

F. Where wireway size is not indicated, size to comply with CEC but not less than applicable minimum size requirements specified.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install raceways in a neat and workmanlike manner in accordance with NECA 1.

C. Install raceways plumb and level.

D. Arrange wireways and associated raceway connections to comply with CEC, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.

E. Secure and support raceways in accordance with Section 26 0529, Hangers and Supports For Electrical Systems at intervals complying with CEC and manufacturer's requirements.

F. Close unused raceway openings.

G. Provide grounding and bonding in accordance with Section 26 0526, Grounding and Bonding for Electrical Systems.

H. Identify raceways in accordance with Section 26 0553, Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. Inspect raceways for damage and defects.

B. Correct wiring deficiencies and replace damaged or defective raceways.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 PROTECTION

A. Protect installed raceways from subsequent construction operations.

END OF SECTION

SECTION 26 0537 – BOXES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Junction and pull boxes larger than 100 cubic inches not subject to vehicular traffic.

C. Underground boxes/enclosures not subject to vehicular traffic.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0534 - Conduit

D. Section 26 0553 - Identification for Electrical Systems.

E. Section 26 2726 – Wiring Devices.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

D. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

G. CEC – California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

H. SCTE 77 - Specifications for Underground Enclosure Integrity

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.

C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by CEC.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to CEC.

4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to CEC.

5. Coordinate the work with other trades to provide wall space suitable for installation of flush-mounted boxes and concealed conduits where indicated.

6. Notify Owner’s Representative of any conflicts with, or deviations from, the contract documents. Obtain direction before proceeding with work.

1.06 QUALITY ASSURANCE

A. Conform to requirements of CEC.

B. Assure product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 BOXES

A. General Requirements

1. Do not use boxes and associated accessories for applications other than as permitted by CEC and product listing.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.

3. Provide products listed, classified, and labeled as suitable for the purpose intended.

4. Where box size is not indicated, size to comply with CEC but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
6. Assure grounding system continuity as required by CEC and install all required bonding fittings and conductors.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use nonmetallic boxes where exposed rigid PVC conduit is used.
5. Use suitable concrete type boxes where flush-mounted in concrete.
6. Use suitable masonry type boxes where flush-mounted in masonry walls.
7. Use raised covers suitable for the type of wall construction and device configuration where required.
8. Use shallow boxes where required by the type of wall construction.
9. Do not use "through-wall" boxes designed for access from both sides of wall.
10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A ; furnish with threaded hubs.
12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
13. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
15. Minimum Box Size, Unless Otherwise Indicated:
    a. Wiring Devices: 4-inch square by 2-1/8 inch deep (100 by 38 mm) trade size.
    b. Ceiling Outlets: 4 inche octagonal or square by 2-1/8 inch deep (100 by 38 mm) trade size.
16. Wall Plates: Comply with Section 26 2726, Wiring Devices.
17. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Eaton Corporation.
    b. Hubbell Incorporated; Bell Products.
    c. Hubbell Incorporated; RACO Products.

d. O-Z/Gedney, a brand of Emerson Industrial Automation.

e. Thomas & Betts Corporation.

C. Junction and Pull Boxes Larger Than 100 cubic inches (1,650cu cm) not subject to vehicular traffic:

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.

2. NEMA 250 Environment Type, Unless Otherwise Indicated:

a. Indoor Clean, Dry Locations: Type 1, painted steel.

b. Outdoor Locations: Type 3R, galvanized steel, stainless steel, or fiberglass.

3. Covers

a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

4. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

5. Manufacturers

a. Cooper B-Line, a division of Eaton Corporation.

b. Hoffman, a brand of Pentair Technical Products.

c. Hubbell Incorporated; Wiegmann Products.

D. Underground Boxes/Enclosures

1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless-steel tamper resistant cover bolts.

2. Size: As indicated on drawings.

3. Depth: As indicated on drawings, but not less than 12 inches.

4. Provide logo on cover to indicate type of service.

5. Applications

a. Sidewalks and Landscaped Areas with no Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.

b. Do not use polymer concrete enclosures in areas subject to vehicular traffic.

6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.

a. Manufacturers

1) Armorcast, Inc.

2) Hubbell Incorporated; Quazite Products

3) Oldcastle Precast, Inc.

b. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field conditions and measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and CEC.

D. Provide separate boxes for emergency power, low-voltage communication, and normal power systems.

E. Unless otherwise indicated, provide separate boxes for extra low voltage and low voltage systems, such as communication and signal.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations

1. Locate boxes to be accessible after all conduit and equipment are installed.

2. Unless dimensioned, box locations indicated are approximate.

3. Locate boxes as required for devices installed under other sections or by others.

   a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726, Wiring Devices.

4. Locate boxes so that wall plates do not span different building finishes.

5. Locate boxes so that wall plates do not cross masonry joints.

6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.

7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.

8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.

9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.

   a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual non-communicating stud cavities or protect both boxes with listed putty pads.

b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.

10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0534, Conduit.

11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Owner's Representative:

a. Concealed above accessible suspended ceilings.

b. Within joists in areas with no ceiling.

c. Electrical rooms.

d. Mechanical equipment rooms.

I. Box Supports:

1. Secure and support boxes in accordance with CEC and Section 26 0529, Hangers and Supports for Electrical Systems, using suitable supports and methods in accordance with structural engineer's details. Where no structural details are provided, the contractor shall provide and submit structural details for review and approval by the authority having jurisdiction.

2. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

4. Use far-side support to secure flush-mounted device boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6mm) or does not project beyond finished surface.

2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3mm) at the edge of the box.

L. Install boxes as required to preserve insulation integrity.

M. Underground Boxes/Enclosures

1. Install enclosure on gravel base, minimum 6 inches deep.

2. Flush-mount enclosures located in concrete or paved areas.

3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.

4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

N. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

O. Close unused box openings.

P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

Q. Provide grounding and bonding in accordance with Section 26 0526, Grounding and bonding for Electrical Systems.

R. Identify boxes in accordance with Section 26 0553, Identification for Electrical Systems.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material prior to installation of conductors.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 0543 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Ducts in concrete-encased duct banks.

B. Pullboxes and pullbox accessories.

C. Manholes and manhole accessories.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0534 - Conduit.

D. Section 27 0543 – Underground Ducts and Raceways for Communications Systems.

E. California Electrical Code (CEC) most recent addition adopted by Authority Having Jurisdiction, including all applicable amendments and supplements.

1.03 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data

1. Manhole and pullbox hardware.
2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
3. Duct-bank materials, including spacers and miscellaneous components.
4. Warning tape.

C. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:

1. For manholes
   a. Duct sizes and locations of duct entries.
   b. Reinforcement details.
   c. Manhole cover design.
   d. Ladder details, where applicable.
   e. Grounding details.
   f. Dimensioned locations of cable rack inserts, pulling-in irons, and sumps.
2. For precast manholes and pullboxes, Shop Drawings shall be signed and sealed by a qualified professional engineer, and shall show the following:
   a. Construction of individual segments.
   b. Joint details.
   c. Design calculations.
   d. Manufacturer’s Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.

D. Coordination Detailing Activity Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings.

E. Product Certificates: For concrete and steel used in underground precast manholes, according to ASTM C 858.

F. Product Test Reports: Indicate compliance of manholes with ASTM C 857 and ASTM C 858, based on factory inspection.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories Including Ducts for Communications and Telephone Service: Listed and labeled as defined in CEC, Article 100 by a testing agency acceptable to the Owner's Representative, and marked for intended use.

B. Comply with ANSI C2.

C. Comply with CEC.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.06 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify the Owner's Representative fourteen days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Owner Representative's written permission.

1.07 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and pullboxes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes and pullboxes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and pullboxes, and as approved by the Owner's Representative.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of amount installed.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MANUFACTURERS

A. Manufacturers: Subject to compliance with project requirements, provide products by one of the following:

1. Underground Precast Concrete Utility Structures
    a. Jensen Precast.
    b. Oldcastle Precast.
    c. Armorcast.
2. Frames and Covers
    a. Alhambra Foundry
    b. Neenah Foundry Co.
    c. E.J. Prescott
3. Nonmetallic Ducts and Accessories
    a. Cantex, Inc.
    b. Spiraduct/AFC Cable Systems, Inc.
4. Duct, Fittings, and Spacers
    a. Carlon
    b. Allied Tube and Conduit
    c. Cantex, Inc.
    d. Underground Devices

2.02 DUCTS

A. For additional requirements, refer to Section 26 0534 – Conduit.

B. PVC duct Schedule 40 (UL listed only): Manufactured in accord with NEMA Standard TC-2 and WC 1094 specifications.

1. Cemented fittings.
2. Spacers: Vertical and horizontal interlocking duct spacers for concrete encasement: High-impact styrene.
3. Riser sweeps for power and communication ducts shall be PVC coated rigid galvanized steel.

C. Rigid steel conduit, elbows and nipples

1. Threaded, hot-dipped galvanized conduit manufactured in accord with ANSI C80.1 and UL 6.
2. Threaded, hot-dipped galvanized fittings manufactured in accord with ANSI C80.4.

2.03 PULLBOXES

A. Cast-Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and AASHTO M306 HS-20 for roadways, parking lots and loading docks.

B. Precast Pullboxes: Polymer concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of pullbox. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and AASHTO M306 HS-20 for roadways, parking lots and loading docks.

C. Cover Legend: “HIGH VOLTAGE”, "ELECTRIC" Or “COMMUNICATIONS”, as necessary and as shown on plans.

2.04 PRECAST MANHOLES

A. Precast Units: ASTM 478, with interlocking mating sections, complete with accessories, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Dimensions: As shown on plans and required by CEC.

C. Design and fabricate structure according to ASTM C 858.

D. Structural Design Loading: ASTM C 857, Class A-16 (AASHTO HS20).

E. Base section:6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.

F. Riser Sections: 4-inch minimum thickness, and lengths to provide required depth. Approved by Owner Representative.

G. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

H. Steps: ASTM A 615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches.

I. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.

J. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

K. Protective Coating: Plant-applied, coal-tar, epoxy-polyamide paint 15-mil minimum thickness applied to exterior and interior surfaces.

L. Source Quality Control: Inspect structures according to ASTM C 1037.

2.05 ACCESSORIES

A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts.

B. Manhole Frames and Covers: Comply with AASHTO loading specified for manhole; Ferrous frame 36-inch clear ID by 6 inch minimum riser with 4-inch-minimum width flange and 36 -inch-diameter cover.

1. Provide cast covers with cast-in legend

a. “ELECTRIC" or “ELECTRICAL” for duct systems with wires and cables for systems operating at 600 V and less.

b. "HIGH VOLTAGE" for duct systems with medium-voltage (above 600V) cables.

c. "COMMUNICATION" for communications, data, and telephone duct systems.

d. Bead-weld manhole identifier (HMH, HPB, EMH, EPB, CMH, or CPB, along with manhole/pullbox ID per plans) onto cover.

2. Cast iron with cast-in legend as indicated above subsection 1. Milled cover-to-frame bearing surfaces.

3. Manhole Frames and Covers: ASTM A 48; Class 30B gray iron, 36-inch size, machine-finished with flat bearing surfaces.

C. Sump Frame and Grate: ASTM A 48, Class 30B gray cast iron.

D. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 2-inch- diameter eye and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

E. Pulling and Lifting Irons in Floor: 7/8-inch- diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

F. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

H. Cable Stanchions: Hot-rolled, hot-dip-galvanized, T-section steel; 2-1/4-inch size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

I. Cable Arms: 3/16-inch- thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 12 inches wide by 14 inches long and arranged for secure mounting in horizontal position at any location on cable stanchions.

J. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Grounding Materials: Comply with Section 26 0526 "Grounding and Bonding for Electrical Systems."

L. Duct Sealing: Removable, reusable conduit seals, such as Raychem type RDSS, Polywater FST Ductseal, or equal.

M. Warning Tape: Underground-line warning tape specified in Section 26 0553 “Identification for Electrical Systems."

2.06 CONSTRUCTION MATERIALS

A. Seal manhole section joints with sealing compound recommended by the manhole manufacturer.

B. Comply with Division 07 for damp proofing.

C. Mortar: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

D. Concrete: Use 3000-psi- minimum, 28-day compressive strength and 1-inch maximum aggregate size. Concrete and reinforcement are specified in Division 03. Provide red dye added to concrete during batching for medium voltage as follows:

1. 2.0 lbs. of dye per 94 lb. bag of cement.

PART 3 - EXECUTION

3.01 APPLICATION

A. Underground Ducts for Electrical Cables Higher Than 600 V: Type EPC-40-PVC, concrete-encased duct bank.

B. Underground Ducts for Telephone Utility Service: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-80-PVC when crossing roads.

C. Underground Ducts for Communication Circuits: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-80-PVC when crossing roads.

D. Manholes: Underground precast concrete utility structures.

E. Manholes: Cast-in-place concrete.

3.02 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 but do not use heavy-duty, hydraulic-operated, compaction equipment over ductbank.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

D. Refer to Division 01 for requirements to restore disturbed pavement.

3.03 CONDUIT AND DUCT INSTALLATION

A. Exercise care in excavating, trenching, and working near existing utilities. Locate any existing buried utilities before excavating.

B. Duct bank trench shall be shored, framed and braced for installing ducts. Frames, forms, and braces shall be either wood or steel. Variations in outside dimensions of the installed duct bank shall not exceed 2 inches on the vertical or the horizontal from the design. Remove forms and bracing after 24 hours and before backfilling.

C. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and pullboxes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions. Duct banks shall be laid to a minimum grade slope of 4 inches per 100 feet. This slope may be from one manhole to the next or both ways from a high point between manholes, depending upon the contour of the finished grade.

D. Duct banks shall be installed so that the top of the concrete encasement shall be no less than 30 inches below grade or pavement for primary 12000V power, and not less 24 inches below finished grade or pavement for area-wide communications. As a general rule, depths shall be a minimum of three feet, but not more than six feet. Where power ductbank is installed with less than 30 inches of cover below grade or pavement, provide Engineering calculations for approval of added protection and provide concrete encased rebar cage in accordance with calculations.

E. Curves and Bends: Use manufactured 60 inch minimum elbows for stub-ups at equipment, communication pull boxes or enclosures and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet, both horizontally and vertically, at other locations. Manufactured long radius bends may be used in runs of 100 feet or less on approval from the Owner's representative. Vertical feeder sweep into buildings shall be coated steel.

F. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

G. Duct Entrances to Manholes and Pullboxes: Space end bells approximately 10 inches o.c. for 5-inch ducts and vary proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Where connection to bulkhead of duct bank is made to vaults or existing duct banks, the concrete encasement shall be doweled with on No. 4 reinforcement rod 36 inches long per conduit to the existing encasement.

H. Building Entrances: Make a transition from underground duct to conduit at least 10 feet outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.

2. Direct-Buried, Non-encased Ducts at Non-waterproofed Wall Penetrations: Install a Schedule 40, galvanized steel pipe sleeve for each duct. Calk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.

3. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

I. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Duct joints in concrete may be placed side by side horizontally, but shall be staggered at least 6 inches vertically. Joints shall be made in accordance with manufacturer's recommendations for the particular type of duct and coupling selected. In the absence of specific recommendations, plastic duct connections shall be made by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of duct's ends. The duct and fitting shall then be slipped together with a quick one-quarter turn to set the joint.

3. Concreting: Spread concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope

between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope. At connection to manholes, dowel concrete encasement with on No. 4 reinforcing bar 36 inches long per duct.

4. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Clearances between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.

7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

J. Direct-Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators not more than 4 feet center-to-center along entire length of duct bank including top pipes.

2. Install expansion fittings as shown on Shop Drawings.

3. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 for pipes less than 6 inches in nominal diameter.

4. Backfill: Install backfill as specified in Division 31. After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally. Do not place backfill for a period of at least 24 hours after pouring of concrete.

5. Minimum Clearances between Ducts: 3 inches between ducts for like services and 6 inches between power and signal ducts.

6. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

K. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.

L. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete. Galvanized steel conduits installed below grade shall be painted with two coats of Koppers Bitumastic paint before installing in ground.

M. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

N. Pulling Cord: Install 100-lbf- test nylon cord with length identification in ducts, including spares. Identify opposite end locations at both ends with durable tags.

3.04 MANHOLE AND PULLBOX INSTALLATION

A. Elevation: Install manholes with rooftop at least 18 inches below finished grade. Install pullboxes with depth as indicated. Where indicated, cast pullbox cover frame directly into roof of pullbox and set roof surface 1 inch above grade. Place and align precast manholes to provide horizontal tolerance of 2 inches in any direction and vertical alignment with not greater than 1/8-inch maximum tolerance for 6 feet of depth. Completed manhole shall be rigid, true to dimensions and alignment, and shall be watertight.

B. Drainage: Install drains in bottom of units. Coordinate with drainage provisions indicated. Sumps shall not be knocked out, leave solid.

C. Access: Install cast-iron frame and cover.

1. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

2. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch above finished grade.

D. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole and pullbox chimneys after brick mortar has cured at least three days. Seal manhole section joints with sealing compound recommended by the manhole manufacturer. Penetration into manholes and/or boxes shall be sealed. Provide conduit duct plugs for unused terminator openings of spare conduits in manhole. Do not water seal top removable cover until cable pulling has been completed.

E. Damp proofing: Apply damp proofing to exterior surfaces of units after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, damp proof joints and connections and touch up abrasions and scars. Damp proof exterior of manhole and pullbox chimneys after brick mortar has cured at least three days.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

G. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

H. Grounding: Install ground rod through floor in each structure with top protruding 6 inches above floor. Seal floor opening against water penetration with waterproof nonshrink grout. Ground exposed metal components and hardware with bare-copper ground conductors. Train conductors neatly around corners. Use cable clamps secured with expansion anchors to attach ground conductors.

I. Precast Concrete Manhole Installation: comply with ASTM C 891.

1. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth. Provide a minimum 12-inch level base of ¾ inch crushed rock under manhole to ensure uniform distribution of soil pressure on floor.

3.05 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

B. Grounding: Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 0526 "Grounding and Bonding for Electrical Systems" and Section 26 0800 “Electrical Testing Requirements”.

C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.

D. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.06 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

C. After the duct line has been completed, a brush with stiff bristles shall be pulled through each duct to make certain that no particles of earth, sand or gravel have been left in the line. (Mandrels not less than 12 inches long, having a diameter approximately 1/4 inch less than inside diameter of the duct, shall be pulled through each duct). Leave a polyaramid pull tape in each duct for future use. Refer to Specification Section 26 0534 for pull tape sizes.

END OF SECTION

SECTION 26 0548 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Engineering for all bracing, anchorage and seismic restraints.

B. Vibration isolation for all rotating equipment, inertia bases, and equipment support frames.

C. Vibration isolation for electrical transformers.

D. Seismic restraints for all vibration isolated and non-vibration isolated equipment, conduit.

E. Supervision and inspection of installed vibration isolation hardware.

F. The contractor is responsible for selecting, engineering, and incorporating all bracing, anchorage and seismic restraints. Such restraints must not reduce the vibration isolation capabilities of the system.

1.02 QUALITY ASSURANCE

A. Design Criteria

1. Vibration Isolation: Provide isolation to avoid excessive noise or vibration in the building due to the operation of electrical equipment, or due to interconnected conduit.

2. Anchorage and Bracing: Anchor, support and brace all conduits to resist seismic forces in accordance with requirements for anchorage bracing as specified.

B. Requirements of Regulatory Agencies

1. CBC – California Building Code, California Code of Regulations, Title 24, Part 2, Part 8, Part 10.

1.03 DESIGN RESPONSIBILITY

A. Vibration isolation manufacturer shall:

1. Determine vibration isolation sizes and locations.

2. Provide piping and equipment isolation system as scheduled or specified.

3. Guarantee specified isolation system deflection.

4. Provide installation instructions and drawings.

1.04 SUBMITTALS

A. Comply with 26 0500 for additional submittal requirements and procedures including preparation and transmittals. The submittal shall contain the following information:

1. Catalog cuts and data sheets on specific vibration isolators to be utilized.

2. A table showing the mark of equipment, conduits, etc., to be isolated, the equipment location, the isolator type and model number selected for each piece of equipment, isolator loading and deflection including isolator free height and deflected height, and reference to specific drawing showing frame construction where applicable. For steel spring isolators include solid height and diameter of spring coil.

3. Drawings showing equipment frame construction. Written approval of the frame design to be used from the manufacturer.

4. Seismic restraint requirements including:
    a. Specific details for restraints including anchor bolts for mounting, snubbers, cable size, and the maximum loading at each location.
    b. Method of attachment to conduits, electrical equipment, and structure.
    c. Seismic restraint calculations for all restraints performed and signed by a structural engineer licensed in the State of California.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Manufacturers

1. Vibration isolation
    a. Mason Industries
    b. M.L. Sausse & Co. (Vibrex)
    c. California Dynamics Corporation

2. Supports
    a. B-Line
    b. Superstrut
    c. Unistrut

B. General Requirements

1. All frames, vibration isolation devices and seismic restraints, shall be designed and furnished by a single manufacturer, or supplier, who will be responsible for adequate coordination of all phases of this work.

C. Vibration Isolation

1. General Requirements
    a. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves must be linear over a deflection range 50% above the design deflection.
    b. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
    c. The ratio of lateral to vertical stiffness shall not be less than 0.5 or greater than 1.0.
    d. The vertical static deflection for each support point, based upon the load per isolator and isolator stiffness, shall not differ by more than + or - 10%.
    e. Isolation above the resonant frequency shall follow the theoretical prediction based upon an undamped single degree of freedom system.
    f. Isolators shall be selected by the supplier, even if sizing is shown. Size vibration isolators on single piece of equipment for equal static deflections based on actual static and dynamic weight distribution per point of support furnished by equipment manufacturer. Dynamic loads include those due to: wind, fluid flow, thrust and rotations inertial. Select each isolator

independently for the load distribution on the equipment base, duct or pipe support.

g. In determining weight of equipment, include concrete inertia bases, grout filled pump bases, etc.

h. All static deflections are nominal. Actual installed deflections are to be +15 percent of the specified value.

i. Where static deflections are not specified, provide minimum 2-inch deflection for rotating and reciprocating equipment.

j. Use as few isolators on each equipment as practical. For example, 4 isolators on small equipment and inertia bases.

k. Vibration isolators shall have either known height without a load or other markings so that after adjustment, when fully loaded, the deflection can be verified.

l. Incorporate a resilient neoprene element of 1/4-inch minimum thickness on spring hangers to prevent solid contact between the spring and isolator housing.

m. Install thrust restraints on fans over 3 inches wg static pressure with the same deflection as isolators supporting the fan.

n. All spring isolators laterally stable with leveling bolts. Spring isolators minimum additional "travel" to full compression of half the rated deflection. The ratio of lateral to vertical stiffness shall be 0.9 minimum and 1.5 maximum.

o. Provide all floor-mounted spring isolators with mounting base plates that provide for bolting to the floor and incorporate 1/2-inch thick neoprene bearing pads.

p. Provide EPDM or equal elastomeric elements in place of neoprene on all vibration isolators installed outdoors.

q. Provide neoprene material with anti-ozone and anti-oxidant additives.

r. Cp value as required by Title 24, Part 2, Table 2-23J.

s. Supply all miscellaneous steel to make support compatible with equipment.

t. Confirm seismic calculations and compatibility with particular equipment to be installed. Submit seismic calculations.

u. Mount motors on rigid base common with equipment or supported from equipment frame.

v. Snubbers must not limit vibration isolation capability during normal operation. Where steel limit stops are used, provide 3/4-inch thick neoprene to prevent metal-to-metal impact.

w. Vibration isolation manufacturer representative to supervise and inspect all installed isolation hardware and generate punchlist for the Owner's Representative along with corrective measures required. Submit inspection report.

2. Isolator types: Type of mounting and supporting base and minimum static deflection, as scheduled and required. Mason model numbers used.

   a. Base Mounts

      1) Type NP: Neoprene pad. Waffle, ribbed, or other forms. Typically 3/4-inch thick. Durometers of 40 to 50. Static deflections from 1/8" inch. Provide steel load distribution plates. Size of pad to be specified by isolator supplier based on load per point. Provide grommetted bolt when anchoring. Mason "Super" W and WM, ML Sausse, or equal.

      2) Type NM: Neoprene mounts. Molded one-piece assemblies with skid resistant base plates and mounting holes. Double deflection type with static deflection range from 0.3 to 0.5 inch. Coat metal surfaces with neoprene to prevent corrosion. Provide friction pad. Mason ND, ML Sausse, or equal.

      3) Type SM: Spring mounts. Single or multiple bare steel springs, base plates with neoprene pad. Height saving mounting brackets where applicable, height adjustment bolts. Static deflection range from 1.0 to 5.0 inches nominal. Mason SLFH, ML Sausse, or equal.

      4) Type USM: Unhoused spring mounts. Single or multiple bare steel springs, baseplates with neoprene pad. Height saving mounting brackets where applicable, height adjustment bolts. Static deflection range from 1.0 to 5.0 inches nominal. Mason SLR with C-spring, ML Sausse, or equal.

      5) Type SML: Spring mounts, drop and rise limiting. Same as Type USM multiple spring with assembly fabricated to prevent rise or drop of greater than 1/4-inch when overloaded or when load removed. Withstand 0.5G acceleration in all directions. Mason, SLR, ML Sausse, or equal.

      6) Type SSM: Seismic spring mounts. Single spring, leveling device, maximum 1/4-inch travel. Spring diameters no less than 0.8 of compressed height of spring at rated load. Minimum additional travel to solid equal to 50 percent of rated deflection. Spring inspection ports. Static deflection range from 1.0 to 5.0 inches nominal. Withstand 1.0G acceleration in all directions. Mason SSLFH, ML Sausse, or equal.

      7) Type RSC: Roof spring curb. Roof-mounted spring curbs with continuous perimeter structural steel curb supporting laterally stable coil springs sitting on 1/4-inch neoprene pads. Springs vertically and laterally restrained using neoprene isolated bolts. Provide leveling bolts and cadmium-plated or galvanized hardware. Mason RSC, ML Sausse, or equal.

   b. Hangers

      1) Type NH: Neoprene hangers. Molded neoprene units in a steel hanger frame. Double deflection types with static deflection range from 0.3- to 0.5-inch. Designed to preclude contact of hanger rods with frame (30 degrees misalignment). Insert neoprene bushing where rod passes through housing. Mason HD, ML Sausse, or equal.

2) Type SH: Hanger containing spring in series with deflected neoprene element, load transfer. Same as Type NH with yoke assembly and indicator for load transfer seat spring in neoprene cup with washer to distribute load evenly to cup and to prevent spring-to-casing contact. Mason PC 30N, ML Sausse, or equal.

c. Seismic Snubbers

1) Type SS: All-directional seismic snubber. Mason Z-1225, ML Sausse, or equal.

d. Resilient Attachments

1) Type RA-1: 3/4-inch nominal thickness resilient pipe sleeve between pipe and clamp or hanger.

e. Operating temperature at or below 80 degrees F, except in plenums: Armstrong Armaflex, Manville Aerotube or approved equal.

f. Operating temperature above 80 degrees F or in plenums: preformed glass fiber pipe insulation not exceeding 6 pcf.

1) Type RA-2: Manufactured insulated hanger for uninsulated pipe: Superstrut P/A-716 Cush-A-Clamp, Unistrut, B-line or approved equal.

2) Type RA-3: Manufacturer resilient attachment for water pipes 1 inch and less diameter: Technical Specialties Acousto-Plumb System (orange and blue) or equal.

g. Other Supports

1) Type A: Pipe anchors, vertical or horizontal. Resilient anchor points in piping to preclude direct contact of piping with structure yet provide a neutral point for expansion/contraction or piping. Mason ADA, ML Sausse, or equal.

2) Type T: Trapeze. Supporting sling of steel member with mount or hangers at each end. Used to distribute load or to conserve space.

3) Type S: Stanchion support. A supporting arm or system for equipment or piping between the isolator and load.

4) Type "cable" seismic restraints shall be constructed of 7 by 19 strand galvanized aircraft cable. Cable assembly shall come compete with 2 "U" bolt clamps per end. Allowed loads shall contain a safety factor of three when worse case loading applied to 1 cable. Cable shall be installed with 1/4-inch slack to prevent the transmission of vibration to the structure.

h. Bases

1) Type SF: Structural steel integral frame of wide flange (W) or junior beam (M) members. Rigid fabrication to preclude deflections or frame distortion under dynamic load. Motor mounts, base plate mounts, stanchion support for piping or as shown on Drawings for equipment, pumps, fans, etc. Brackets to prevent drop of frame more than 3/8-inch. Thickness minimum 8 percent longest dimension. Mason WFSL, ML Sausse, or equal.

2) Type B: Brackets to equipment. Height saving brackets attached directly to equipment where rigidity of same does not require

supplemental frame. Drop protection as for Mason Type SF, ML Sausse, or equal.

3) Type IB: Inertia base frame. Welded steel frame with rebar reinforcement and height saving brackets. Provision for air decoupling holes on large units. Unit delivered ready for assembly. Pour of concrete by General Contractor. Preset equipment mount attachment bolts or other hold down methods for equipment involved. Space between bottom of base and floor to be at least 2 inches. Minimum weight equal to one to two times weight of equipment or as noted. Thickness minimum 8 percent largest dimension. Mason KSL, ML Sausse, or equal.

D. Conduit Seismic Supports

1. Provide calculations demonstrating compliance with regulatory requirements. Only known complying systems are "Superstrut Seismic Restraint System", pre-approval No. OPA-0003, and "B-Line Seismic Restraint System", pre-approval No. OPA-0114 and "Tomarco - ISAT Seismic Restraint System", pre-approval No. OPA-0485

2. Cp value as required by UBC Chapter 23, Table 23-P.

E. Expansion Bolts: As specified on structural drawings

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Install vibration isolation equipment in full accordance with the manufacturer's instructions.

2. Suspend the vibration isolators supporting conduits and equipment from structural members.

3. Provide a minimum of 1-inch clearance between the building structure and vibration isolated supports, conduits, and equipment.

4. Provide 2 inches minimum clearance between the top of the housekeeping pad or floor and the underside of concrete inertial pads and/or steel equipment support frames.

5. Fasten all vibration isolators to the structure, not to floor diaphragms or lightweight components. Use bolts where holes are provided in the mounting flanges; otherwise, adhere using structural adhesive. Where mounting flanges are steel, use neoprene grommets and washers under anchor bolts.

6. Do not use vibration isolation components to straighten or connect misaligned sections of conduits.

7. Align spring isolation hanger rods to clear the hanger box under all operating conditions.

8. Any bracing or supports for electrical conduits and equipment shall not bridge or reduce the effectiveness of vibration isolators.

9. Level vibration isolated equipment under rated design operating conditions while maintaining the isolation criteria. Isolators shall be plumb and aligned to preclude misalignment or undesired contact during operation.

B. Conduits

1. Support and brace all conduits as required in CBC Chapter 23, Table 23-P.
2. Use trapezes for vertical support to horizontal piping only. Provide calculations demonstrating compliance with regulatory requirements.
3. No electrical conduit, fixture, ceiling suspension wires or other elements of the building construction shall be attached to or abutted against HVAC duct and piping systems.
4. Install flexible connections at all connections to vibration isolated equipment, rotating, reciprocating and other vibrating equipment, whether isolated or not.

END OF SECTION

SECTION 26 0553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Warning signs and labels.

1.02 RELATED REQUIREMENTS

A. Section 26 0513 – Medium-Voltage Cables

B. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cable.

C. Section 26 0534 – Conduit.

D. Section 26 0537 – Boxes.

E. Section 26 0543 – Underground Ducts and Raceways for Electrical Systems.

1.03 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.

C. CEC – California Electrical Code; Most Recent Addition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

D. NFPA 70E – Standard for Electrical Safety in the Workplace.

E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings: Provide nameplate and label schedule in Microsoft Excel that includes all information, including proposed designations, materials, legends, and formats for each label or nameplate required to be installed for power and communications equipment and cables The Microsoft Excel spreadsheet shall be submitted and approved prior to fabrication and installation.

1.05 QUALITY ASSURANCE

A. Conform to requirements of CEC, UL, and OSHA requirements for equipment labeling and hazard warning identification.

B. Labels and nameplates shall be the colors designated in this spec unless otherwise noted.

1.06 CAMPUS EQUIPMENT NAMING CONVENTION

A. 12000V Manholes, Pull Boxes

1. MH-XX, PB-XX

a. MH: High Voltage Man Hole

b. PB: High Voltage Pull Box

c. XX: Manhole/pull box unique identification number.

B. 12000V Switches

1. OFC-XX-YY, OFS-XX-YY, SDS-XX-YY, or SF6 -XX-YY

a. OFC: Oil Fuse Cutout. Only OFC's installed on campus are at Student Housing Phase 1.

b. OFS: Oil Filled Switch. Examples are Switches by Engineering, Library, King Hall.

c. SDS: Solid Dielectric (Vacuum) Switch.

d. SF6: SF6 gas-filled switch.

e. XX: Refers to the building number that the equipment is located in or near.

f. YY: Equipment unique identification number.

g. Example: SF6 Switch 02 located near building number 03 will be identified as SF6-03-02.

C. Load Interrupter Switches

1. LIS-XX-Y

a. LIS: Load Interrupter. Example is in Simpson Tower Basement, feeding Simpson Tower/Salazar.

b. XX: Building Number

c. Y: Unique number for each load interrupter switch.

d. Example: Load Interrupter Switch 2 in Building 14 will be labeled as LIS-14-2.

D. Building 12000V Transformers (Main Service Transformers for Buildings)

1. SUB-XX

a. SUB: Substation

b. XX: Building Number

E. 600V and Less Pull or Junction Boxes

1. JB-XX-YY

a. JB: Pull or Junction Box

b. XX: Building Number

c. YY: Junction/Pull Box unique identification number.

F. Communication/Signal Manholes, Pull Boxes

1. TMH-XX, TPB-XX

a. TMH: Communication/Signal Man Hole

b. TPB: Communication/Signal Pull Box

c. XX: Manhole/pullbox unique identification number.

G. Sample Building Electrical Equipment Numbering Scheme (600V And Less)

1. The following designations shall be used to identify equipment operating at 600V or less:

Equipment Type	Label Designation
Building Main Service Board	MSB
Transformer	T
Distribution Board or Power Panel	DB
480V Panelboard	HPB
240V/120V or 208V/120V Panelboard	PB
Pull or Junction Box	JB
Disconnect Switch	DS
Fused Disconnect Switch	FS
Emergency Lighting Inverter	INV
Uninterruptible Power Supply	UPS
Motor Control Center	MCC
Variable Frequency Drive	VFD
480V Motor Starter Cabinet	HMC
240V or 208V Motor Starter Cabinet	LMC
Automatic Transfer Switch	ATS
Generator	GEN
Fire Alarm Control Panel	FACP

2. Each 600V system identification label shall include the building number, equipment type and item number. For instance, building number 01, 208V panelboard number 3 nameplate would read:

a. PB-01-03

3. A 480Y/277V – 208Y/120V transformer number 3 in Building 4 would read:

a. T-04-03

1.07 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

B. Do not install identification products until final surface finishes and painting are completed.

C. Nameplates and labels shall be installed so they are readily visible and legible.

PART 2 - PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Contractor shall provide and install new identification labels for all new equipment, and existing equipment where new equipment, such as feeders, are being installed.

B. Nameplates and labels shall confirm to the Drawings and Owner’s electrical equipment and cable numbering schemes.

C. Identification for Equipment

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.

a. Switchgear, Switchboards, Motor Control Centers, and Power Distribution Panelboards

1) Use identification nameplate to identify the name of the power equipment.

2) Identify power source and circuit number where applicable. Include location when not within sight of equipment.

3) Use identification nameplate to identify main and tie devices.

4) Use identification nameplate to identify load(s) served for each feeder and branch device. Identify spares. Do not identify spaces.

b. Lighting and Appliance Panelboards

1) Use identification nameplate to identify the name of the panelboard.

2) Identify power source and circuit number where applicable. Include location when not within sight of equipment.

3) Identify main overcurrent protective device.

4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.

5) For panelboards without a door, use identification nameplate to identify load(s) served for each branch device and spares. Do not identify spaces.

c. Enclosed Switches, Enclosed Circuit Breakers, and Motor Controllers

1) Use identification nameplate to identify the name of the switch, breaker, or controller.

2) Identify power source and circuit number. Include location when not within sight of equipment.

3) Use identification nameplate to identify load(s) served including location when not within sight of equipment.

d. Transformers

1) Use identification nameplate to identify the name of the transformer.

2) Identify power source and circuit number. Include location when not within sight of equipment.

3) Use identification nameplate to identify load(s) served including location when not within sight of equipment.

e. Transfer Switches

1) Use identification nameplate to identify the name of the transfer switch.

2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.

3) Identify load(s) served. Include location when not within sight of equipment.

f. Electric Meters

1) Identify load(s) metered.

2. Service Equipment

a. Use identification nameplate to identify each service disconnecting means.

b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

c. Provide available short circuit duty label at the main service entrance with data from short circuit study, per CEC 110.24.

3. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

4. Use handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.

5. Use handwritten text and indelible marker to label inside door of switchboards, MCC's, and other equipment with phase sequence measured after energization.

6. Use floor marking tape, to identify required equipment working clearances, yellow 1-½ inch wide outlining the working space.

7. Arc Flash Hazard Warning Labels: Comply with Section 26 0573, Electrical Power System Study.

8. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

9. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

10. Use warning identification nameplates to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

D. Identification for Conductors and Cables

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519, Low-Voltage Electric Power Conductors and Cables.

2. Use wire and cable markers to identify circuit number and source panel number or other designation indicating control and instrumentation conductors and cables at the following locations:

a. At each source and load connection. Branch circuit number is not requited in the source panel.

b. Within boxes with splices.

3. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

E. Identification for Raceways:

1. Use voltage warning label to identify accessible conduits and raceways with voltages over 600 volts at maximum intervals of 20 feet.

2. Purchase pre-colored raceway for special systems and as required by the Codes. Field apply paint to all conduit and boxes that are not pre-colored or the correct color.

a. Color Code

1) Fire Alarm System: Red

3. Use handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.

4. Use underground warning tape to identify underground raceways.

F. Identification for Manholes

1. Manhole Covers shall be provided with the following identification cast into the cover:

a. “HIGH VOLTAGE” for manholes containing conductors operating at a voltage greater than 600V.

b. “ELECTRIC” for manholes containing only power/lighting conductors operating at 600V or less.

c. “COMMUNICATION” for manholes containing copper and/or fiber communication cables.

2. Bead-weld manhole identifier (MH, TMH along with ID number per plans) into manhole cover.

G. Identification for Pullboxes

1. Concrete pullbox covers shall be provided with the following identification engraved into the cover:

a. “ELECTRIC” for pullboxes containing only power/lighting conductors operating at 600V or less.

b. “GROUND” for pullboxes containing a ground rod or ground conductors only.

c. “COMMUNICATION” for pullboxes containing copper and/or fiber communication cables.

2. Metal pullbox covers shall have the following information welded onto the cover:

a. “ELECTRIC” for pullboxes containing only power/lighting conductors operating at 600V or less.

b. “COMMUNICATION” for pullboxes containing copper and/or fiber communication cables.

c. Bead-weld pullbox identifier (PB, TPB, along with ID number per plans) into pullbox cover.

H. Identification for Boxes

1. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the message reading as follows: "DANGER; HIGH VOLTAGE; KEEP OUT".

2. Purchase pre-colored raceway for special systems and as required by the Codes. Field apply paint to all conduit and boxes that are not pre-colored or the correct color.

a. Color Code

1) Fire Alarm System: Red

I. Identification for Devices

1. Use adhesive identification label or engraved wall plate to identify serving branch circuit and source panel for all receptacles.

2. Use identification label or engraved wall plate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

3. Use identification label to identify fire alarm system devices.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates

1. Materials

a. Indoor Locations: Use engraved laminated plastic nameplates.

b. Outdoor Locations: Use engraved laminated plastic, anodized aluminum, or stainless-steel nameplates. Nameplates shall be suitable for exterior use.

2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch (1.6 mm); engraved text.

3. Aluminum or Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.

4. Mounting Holes for Mechanical Fasteners: Two (2), centered on sides for sizes up to 1 inch (25 mm) high; Four (4), located at corners for larger sizes.

B. Identification Labels

1. Materials: Use adhesive labels, UV and water resistant.

2. Laminated labels are acceptable for branch circuit device identification.

C. Format for Equipment Identification

1. Minimum Size: 1 inch by 2.5 inches.

2. Legend

a. System designation where applicable

1) Emergency Power System: Identify with text "EMERGENCY".

2) Fire Alarm System: Identify with text "FIRE ALARM".

b. Equipment designation or other approved description.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height

a. System Designation: 1/8 inch.

b. Equipment Designation: 1/8 inch.

c. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.

5. Color

a. Normal Power System: White text on black background.

b. Emergency Power System: White text on red background.

c. Fire Alarm System: White text on red background.

D. Format for Caution and Warning Messages

1. Text: All capitalized unless otherwise indicated.

2. Minimum Text Height: 3/8 inch.

3. Color: Black text on yellow background unless otherwise indicated.

E. Format for Receptacle Identification

1. Legend: Power source and circuit number or other designation indicated.

2. Text: All capitalized unless otherwise indicated.

3. Minimum Text Height: 3/16 inch.

4. Color: Black text on clear background.

F. Format for Control Device Identification

1. Minimum Size: 3/8 inch by 1.5 inches.

2. Legend: Load controlled or other designation indicated.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 3/16 inch.

5. Color: Black text on clear background.

G. Format for Fire Alarm Device Identification

1. Minimum Size: 3/8 inch by 1.5 inches.

2. Legend: Designation indicated and device zone or address.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 3/16 inch.

5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

A. Manufacturers

1. Brady Corporation

2. Thomas & Betts

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

2.04 UNDERGROUND WARNING TAPE

A. Materials: Use foil-back detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 6 inches wide, with minimum thickness of 5 mil.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color

1. Tape for Buried Power Lines: Black text on red background.

2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.05 FLOOR MARKING TAPE

A. Manufacturers

1. 3M

2. Brady

3. Thomas & Betts.

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with over laminate, 1 1/2 inches wide, yellow.

2.06 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs

1. Materials

a. Use factory pre-printed rigid plastic signs.

2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.

3. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.

2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.

3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean surface to receive adhesive products according to manufacturer’s instructions.

3.02 INSTALLATION

A. Provide and install new labels for all new equipment. Provide and install labels for new feeder cables installed in existing manholes and pullboxes. Provide and install new identification labels for re-labeled manholes and pullboxes per Drawings, where new feeder cables are installed within the existing manhole or pullbox.

B. Install products in accordance with manufacturer's instructions.

C. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also label enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: On device cover plate, or adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conductors and Cables: Legible from the point of access.

D. Install nameplates and identification products centered, level, and parallel with lines of item being identified.

E. Secure nameplates and identification plates to surfaces of enclosures using silicone adhesive or stainless steel screws or rivets. The use of double sided tape is unacceptable.

F. Install Identification Labels and markers to achieve maximum adhesion, with edges properly sealed.

G. Install underground warning tape above buried lines with one tape per trench at 12 inches above the buried line.

H. Secure rigid signs to doors using silicone adhesive or stainless steel screws or rivets. The use of double sided tape is unacceptable.

I. Secure rigid signs to gates using stainless steel clamps and stainless steel screws.

J. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit excessive bubbles, wrinkles, curling or other signs of improper adhesion.

B. Replace any nameplates or labels that do not match the Owner’s identification scheme, or project documents.

END OF SECTION

SECTION 26 0573 – ELECTRICAL POWER SYSTEM STUDY

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes services necessary to be provided by the Contractor to complete the system analysis studies required for the item specified under this Division, including but not limited to:

1. Short circuit study
2. Protective device evaluation study
3. Protective device coordination study
4. Arc Flash Hazard Analysis
5. Cable Heating and Ampacity Study

B. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with equipment specified elsewhere to perform a complete analysis study.

C. Description of Work: The Short Circuit study, Protective Device Evaluation Study, and Arc Flash Hazard Study shall include all permanently installed equipment and protective devices operating at 50V or greater. The Protective Device Coordination study shall include all adjustable trip circuit breakers in the electrical distribution system, and provide recommended settings to provide suitable protection and selectivity for phase and ground overcurrent conditions. Separate analyses shall be performed that model loads fed from normal and emergency sources. The Cable Heating and Ampacity study shall determine ampacities of the installed cables based on installation configuration and building loads.

1.02 REFERENCES

A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified.

1. IEEE STD 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants (Red Book)
2. IEEE STD 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book)
3. IEEE STD 399 – IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis
4. California Code of Regulations, Title 24, Part 3- California Electrical Code (CEC)
5. NFPA 70E: Standard for Electrical Safety in the Workplace
6. IEEE 1584 2002/2004a, Guide for Performing Arc Flash Hazard Analysis.

B. Division 26 and 33 specification sections and drawings are interrelated. Use Divisions 26 and 33, in its entirety, and accompanying electrical drawings for interpreting Power System Study requirements.

C. California Electric Code (CEC) most recent addition adopted by Authority Having Jurisdiction, including all applicable amendments and supplements.

1.03 SUBMITTALS

A. Comply with 26 0500 for additional submittal requirements and procedures.

B. Submit in accordance with the project requirements the following items:

1. The results of the Studies shall be summarized in a final report. Six (6) bound copies and one electronic copy in PDF format of the final report shall be submitted.

2. The report shall include the following Sections:

a. Description, purpose, basis and scope of the study and a single line diagram of that portion of the power system, which is included within the scope of the study.

b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.

c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding it.

d. Fault current calculations including a definition of terms and guide for interpretation of computer printout

e. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays.

f. Arc Flash Hazard analysis, hazard level category identification, Arc Flash Hazard labeling requirements. Arc Flash Hazard analyses shall be modeled with building loads fed from normal and emergency sources, where applicable.

g. Cable Heating and Ampacity summary report.

C. The study shall be submitted to the Owner's Representative prior to final review of the distribution equipment shop drawings and prior to release of equipment for manufacture. If formal completion of the study may cause delay in equipment manufacture, approval from the Owner's Representative may be obtained for a preliminary submittal of sufficient data to ensure that the selection of device ratings and characteristics will be satisfactory. Then the formal study will be provided to verify the preliminary findings.

D. Contractor’s independent consultant shall provide complete ETAP or SKM software data files with all device and equipment information and study results to Owner. The project data files will be integrated into the existing campus SKM project file that is representative of the overall campus.

1.04 QUALITY ASSURANCE

A. An independent consultant or testing company not directly involved in the supply of the equipment and third-party testing shall perform the systems analysis studies. The independent consultant or firm shall be retained by the Contractor or equipment manufacturer.

B. The firm performing the study should be currently involved in high- and low-voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional electrical engineer in the State of California. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Owner for approval prior to start of the work.

C. A minimum of ten (10) years’ experience in power system analysis is required for the individual in charge of the project.

D. The firm performing the study should demonstrate capability and experience to provide assistance during start up as required. Examples of such assistance includes, but not

limited to, adjustment of settings due to varying CT or VT ratios, or different relays or trip units than was included in the original study. The final report and ETAP or SKM project file shall reflect as-built equipment and conditions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE SOFTWARE PROGRAMS

A. Only the following software program is acceptable for performing the Power System Studies. No other software is acceptable without prior approval from the Owner:

1. Power Tools for Windows (Dapper-1000 bus minimum, Captor, Equipment Evaluation, PTW Arc Flash), latest version, by SKM Systems Analysis, Inc., no equal.

2. ETAP for Windows by ETAP

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall provide the required data for preparation of the studies. The Firm performing the system studies shall furnish the Contractor with a listing of the required data immediately after award of the contract.

B. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacturing.

C. The system Short Circuit Study, Protective Device Evaluation Study, Protective Device Coordination Study, Arc Flash Hazard Analysis and Duct Bank Heating shall be based on available load current and fault current stated by the Owner and the utility provider at the point of service. The Contractor shall coordinate with the utility provider and be responsible for obtaining an available fault current letter from the utility. The Short Circuit Study, Protective Device Evaluation Study, Protective Device Coordination Study, and Arc Flash Hazard Analysis shall also include all facility distribution generation and generator short circuit duty contributions. The Firm performing the study shall include a summary of all short circuit sources and all assumptions made to complete the study.

D. The Drawings and Specifications indicate the general requirements for the electrical equipment being provided. Upgrade and modification to equipment characteristics and ratings shall be finalized by the results of the short circuit and protective device coordination studies. Field settings of devices, adjustments, upgrading and modifications to the new equipment to accomplish conformance with the accepted short circuit and protective device coordination studies shall be carried out by the Contractor at no additional cost to the Owner.

E. The Owner will provide the existing active ETAP or SKM backup project files for use and reference on this project. The existing project files shall be modified and revised during this project and returned to Owner as a record document, including all data files needed for future use.

3.02 POWER SYSTEM STUDY

A. Short Circuit Study

1. The short circuit study shall be performed with the aid of a computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.

2. In addition to the software generated printouts, the report shall include a short circuit device evaluation table that lists all the equipment with their associated AIC ratings, X/R ratio, phase and ground fault levels, percentage of fault current vs. AIC rating.

3. The study input data shall include the maximum available short circuit contribution, resistance and reactance components of the branch impedance, the X/R ratios, base quantities selected, and other source impedance.

4. Short circuit close and latch duty values and interrupting duty values shall be calculated on the basis of maximum available current at each substation bus, switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution switchboard, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include asymmetrical fault currents, symmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.

5. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, switches, automatic transfer switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Inadequacies in the equipment due to calculated short circuit currents shall be promptly brought to the Owner's and Engineer's attention.

6. Contractor shall obtain settings or AIC ratings for all mechanical systems equipment, packaged chiller and/or motor starters, equipment and lighting control panels, and other line voltage connected equipment from the equipment supplier.

7. Ground Fault Study: Provide short circuit study for phase-to-ground fault currents. Ground fault current magnitudes shall be used as the basis for recommending coordinated ground fault protection.

B. Coordination Study

1. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, ground fault relays and low voltage breaker trip characteristics and settings.

2. The studies shall be in accordance with the latest applicable IEEE and ANSI standards.

3. The coordination study shall include all medium and low voltage classes of equipment from the building service protective devices down to and including the largest rated device in the low voltage motor control centers and panelboards. The phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices, including the ground fault system devices. 12kV feeder circuit breaker shall coordinate with the largest downstream protective device.

4. The time-current characteristics of the specified protective devices shall be drawn on log-log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip

settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the California Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.

5. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment and recommended settings. A tabulation of the recommended power fuse selection shall be provided for the medium voltage fuses where applied in the system. Any discrepancies, problem areas, or inadequacies shall be promptly brought to the Engineer's attention.

C. Arc Flash Hazard Analysis

1. An Arc-Flash hazard analysis shall be performed in accordance with 2018 NFPA 70E to determine the incident energy and flash hazard boundary resulting from an arcing fault. Hazard categories and required PPE shall be identified based on incident energy levels.

2. The Arc Flash Hazard Analysis shall include all equipment that may be serviced or inspected by personnel while energized, including but not limited to switchboards, switchgear, motor control centers, transfer switches, panelboards, control panels, relay panels, and fused disconnects.

3. Arc Flash Warning labels shall be produced by the Firm performing the studies for all equipment included in this project. Warning labels shall notify personnel of arc-flash hazards, and list arc incident energy at the specified working distance, flash hazard boundaries, approach boundaries, and required PPE to be worn by personnel working on the equipment while it is energized. The Arc Flash module of ETAP or SKM PowerTools for Windows is required to be used for calculation of incident energy and hazard categories.

4. Arc Flash Warning labels must have minimum dimensions of 4" height, 6" width, and have UV, solvent, and water-resistance. Labels shall be printed using thermal transfer label printers on vinyl stock. Labels shall be produced using Duralabel PRO printers or equal.

5. Hazard Categories must be calculated in accordance with IEEE and NFPA methods. Hazard Categories must be calculated when equipment is fed from normal and emergency sources. The operating scenario that provides the worst-case incident energy values shall be represented in the final report and included on the Arc-Flash warning labels.

6. Incident Energies and Hazard Categories must be calculated. The use of the NFPA "table method" to determine Hazard Risk Categories is unacceptable.

7. Arc Flash Warning labels must be installed by the Contractor prior to commissioning of equipment. Labels must be placed on equipment in a location clearly visible to personnel before work is started on the equipment.

    a. Arc Flash Warning Labels with calculated values must be provided for the following equipment including but not limited to:

        1) Switchgear, with values calculated for front and back doors. Provide an arc flash label for the front and back of each vertical section.

        2) Panelboards

        3) Enclosed Circuit Breakers

        4) Low-Voltage Disconnects

        5) Automatic Transfer Switches

        6) Padmount Transformer Primary and Secondary Compartments

        7) Lighting Inverter

        8) Battery Charger

D. Protective Device Testing, Calibration and Adjustment

1. The Contractor shall provide the services of an Owner approved third-party testing firm, necessary tools and equipment to test and calibrate the protective relays, ground fault relays and circuit breaker trip devices as recommended in the Power System Study and as required in the project Specification 26 0800.

END OF SECTION

SECTION 26 0800 – ELECTRICAL TESTING REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Acceptance testing of equipment installed as part of this project.

B. Testing requirements specific to components being tested.

C. Test Report Requirements.

D. Provide the services of an Owner Approved recognized independent testing firm to perform testing work, including but not limited to:

1. Overcurrent protective devices.
2. Grounding.
3. Low-Voltage 600-Volt Maximum Cables.
4. Medium Voltage Cables.
5. Power distribution panelboards.
6. Lighting and appliance panelboards.
7. Liquid-Filled Transformers.
8. Electrical Power Metering.
9. Protective Relays, Microprocessor Based.
10. Circuit Breakers, Medium Voltage.
11. Instrument Transformers
12. Enclosed Switches.
13. Direct Current Systems, Batteries, Valve Regulated.
14. Direct Current Systems, Chargers.
15. Inverter.
16. Fiber Optic Cables.

1.02 RELATED REQUIREMENTS

A. Test procedures specified in this Section are in addition to that specified in other Sections of Division 26.

1. 26 0513 Medium-Voltage Cables
2. 26 0519 Low-Voltage Electrical Power Conductors and Cables
3. 26 0526 Grounding and Bonding for Electrical System
4. 26 1219 Pad-Mounted, Medium-Voltage Transformers
5. 26 1319 Medium-Voltage Metal Clad Switchgear
6. 26 2416 Panelboards
7. 26 2713 Electrical Power Metering
8. 26 2817 Enclosed Circuit Breakers
9. 26 3313 Battery

10. 26 3323 Emergency Lighting Inverter and Battery
11. 26 3346 Battery Charger
12. 27 1323 Communications Optical Fiber Cabling
13. 27 1500 Communications Horizontal Cabling

1.03 REFERENCE

A. Perform inspections and tests in accordance with the following codes and standards:

1. National Electrical Manufacturers Association - NEMA.
2. American Society for Testing and Materials - ASTM.
3. Institute of Electrical and Electronic Engineers - IEEE.
4. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
5. American National Standards Institute -ANSI.
6. State and local codes and ordinances.
7. Insulated Cable Engineers Association - ICEA.
8. Occupational Safety and Health Administration - OSHA.
9. CEC – California Electrical Code
10. NFPA 70E: Standards for Electrical Safety in the Workplace

B. Division 26 specification sections and drawings are interrelated. Use Division 26, in its entirety, and accompanying electrical drawings for interpreting inspection and testing requirements.

C. Use manufacturer's instruction manuals applicable to each particular apparatus for special inspection and testing requirements.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Provide the following certified test report information, including but not limited to:

1. Summary of job.
2. Description of equipment tested.
3. Description of test procedure.
4. List of test equipment and calibration date.
5. Test results, except for the thermographic survey which will be handled as a separate submittal.
6. Conclusions and recommendations.
7. Appendix, including all field test reports.

C. Submit report and test documents together using index in PDF format. Also provide index tabs in 3 ring binder if required by Owner.

D. Provide a copy of test date sheets after completion of any test prior to leaving the site. Report may be typed or printed. List the equipment tested, describe any deficiencies found and recommended corrections. Leave report copies with the Inspector of Record (IOR) and General Contractor.

E. One week before issuing the notice of project work completion, perform thermographic survey testing. The thermographic survey report will be a separate submittal. Thermographic survey shall be completed with the electrical system under “fully loaded” conditions.

F. Provide the following certified thermographic survey test report information, including but not limited to:

1. Summary of job.
2. Description of equipment tested.
3. Description of test procedure.
4. List of test equipment and calibration date.
5. Test results.
6. Discrepancies.
7. Temperature difference between the area of concern and the reference area.
8. Probable cause of temperature difference.
9. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
10. Identify load conditions at time of inspection.
11. Provide photographs and/or thermograms of the deficient area.
12. Conclusions and recommendations
13. Appendix, including all thermographic field test reports.

G. Secure the thermographic survey test report and test thermographic documents together using index in PDF format. Also provide index tabs in 3 ring binder if required by Owner.

H. Thermographic survey test report may be typed or printed. List the equipment tested, describe any deficiencies found and recommended corrections. Leave report copies with the Inspector of Record (IOR) and General Contractor.

1.05 TESTING AGENCY QUALIFICATIONS

A. Company that is a financially independent testing organization which can function as an unbiased testing authority, professionally independent of the contractor, manufacturers, suppliers and installers of equipment or systems evaluated by the testing firm.

B. Meets or has the qualifications for membership of the International Electrical Testing Association, specializing in the testing of equipment or apparatus specified in this Section with minimum 5 years’ experience.

C. See list of pre-approved testing firms in section 2.01.

D. Substitutions comply with Section 26 0500 for additional requirements and procedures. Submit the following for Owner review and approval.

1. Company Name and primary contact.
2. Company overview.
3. Qualifications.
4. Test technician qualifications.
5. Project summary of five projects completed in the last two (2) years with a similar scope of work.

1.06 DIVISION OF RESPONSIBILITY

A. Routine work performed by the Contractor prior to and in addition to tests performed by the testing firm:

1. Cleaning of equipment and apparatus.
2. Insulation-resistance and continuity test for 600V cable.
3. Phase rotation test.
4. Equipment bolt torqueing.
5. Inspect for physical damage.
6. Proper equipment connection and operation.

B. The Contractor has the option to assign all or any portion of above listed routine work to the testing firm at his own expense.

C. The Contractor shall provide suitable and stable source of electrical power to each test site as required by the testing firm.

D. The Contractor shall notify the Inspector of Record (IOR) and the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

E. The testing firm shall notify the Owners Representative prior to commencement of any testing.

F. Report any system, material, or workmanship which is found defective on the basis of acceptance tests to the Owners Representative in writing.

G. The testing firm shall maintain a written record of all tests and, upon completion of project, assembles and certifies final test report.

H. Safety and Precautions:

1. Safety practices include, but are not limited to, the following requirements:
    a. Occupational Safety and Health Act.
    b. Accident Prevention Manual for Industrial Operations, National Safety Council.
    c. Applicable state and local safety operating procedures.
    d. Owner’s safety practices.
    e. National Fire Protection Association – Standard for Electrical Safety in the Workplace – NFPA 70E.
    f. American National Standards for Personnel Protection.
2. Testing shall be performed with apparatus de-energized, unless the equipment needs to be energized for testing. Exceptions, including Thermographic survey, must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
3. The testing firm shall provide a designated safety representative on the project to supervise the testing operations with respect to safety.

PART 2 - PRODUCTS

2.01 TESTING FIRMS

A. Electrical Reliability Services / Vertiv

B. Power Systems Testing

C. Hampton Tedder Technical Services

D. Applied Engineering Constants

2.02 TEST EQUIPMENT

A. The testing agency shall provide all required test equipment.

B. Care and Precautions:

1. Contractor is responsible for any damage to equipment or material due to improper test procedures or test apparatus handling. Replace or restore to original condition any damaged equipment or material.

2. Provide and use safety devices such as rubber gloves and blankets, protective screen, barriers, and danger signs to adequately protect and warn all personnel in the vicinity of the tests.

3. Use test equipment that is calibrated and certified traceable to the National Institute of Standards and Technology. Certification date: Certification must be current and no more than 1 year duration.

PART 3 - EXECUTION

3.01 APPLICATION

A. General

1. Provide all necessary materials, supplies, tools, equipment, labor, and services required to perform all tests as specified in this Section.

2. Contractor is responsible to correct all deficiencies revealed by tests. Replace at contractors' cost, all materials and equipment supplied by the contractor that are found faulty.

3. The testing intent is to assure that all electrical equipment, both contractor and Owner supplied, is operational within industry and manufacturers tolerances and is installed in accordance with design specifications.

4. The test and inspections determine the suitability for energization.

5. Use the International Electrical Testing Association (NETA) guidelines for testing procedures and acceptance test values of results.

6. Complete all test prior to commissioning and final acceptance.

7. Protective device settings shall be applied based on the owner approved coordination and arc flash study. Testing of the protective devices shall not be performed prior to receiving the approved protective device settings.

B. Summary

1. Testing listed below is to assure proper installation, setting, connections, and functioning in accordance with the Drawings, Specifications, and the manufacturer's recommendations. It is the intent that field testing be extensive, and complete as specified, to provide positive assurance of totally correct installation and operation of equipment.

2. When conducting tests, comply with the following:

   a. Notify the Owner and Inspector of Record at least 2 weeks prior to commencement of any testing.

   b. Conduct all tests in the presence of the Owner's Representative and Inspector of Record except when advised that his presence will not be necessary.

   c. Include all tests and inspections recommended by the equipment manufacturer whether required by these Specifications or not, unless specifically waived by the owner.

   d. Maintain a written record of all tests showing date, personnel making test, equipment or material tested, tests performed, manufacturer and serial number of testing equipment and results.

3. Tests include, but are not limited to, the following:

   a. Circuit Breakers: Function within trip curve tolerances.

   b. Grounding system: Ground resistance (impedance), ground integrity.

   c. Ground Fault System: Neutral free of improper grounds.

   d. Feeder Cables: Exhibit correct phase continuity, rotation, and free of shorts and grounds.

   e. Transformers: Exhibit proper turns ratio, liquid level, sturdy and secure parts, free of short circuits and grounds, cabling secure to breakers, and accessories are in place.

   f. Relays and Programmable Controllers: Upload relay programming files, verify proper operation within time-current tolerances.

   g. Switchgear, and Power Distribution Panelboard Assemblies, Lighting and appliance panelboards, Small Power Centers, and Enclosed Circuit Breakers: Installed for sturdy and secure parts, free of short circuits and grounds, cabling secure to breakers, and accessories are in place.

   h. Enclosed Switches: Operate freely, with minimal contact resistance.

   i. DC Systems: Chargers operate in bypass mode, system switches to battery backup, proper voltages are maintained, batteries do not exhibit abnormal discharge.

4. See technical requirements section below for detailed test requirements.

3.02 TECHNICAL REQUIREMENTS

A. Circuit Breakers

1. Circuit Breakers, Air, Insulated-Case/Molded-Case for all breakers in new power distribution panelboards, and any breaker that are new or replacing existing shown on the one-line diagrams. Include breakers that are shown on one line for main protection of lighting and appliance panelboards, i.e. breaker symbol with size is

shown for the main or one of the feeder breaker then those breakers shall be tested.

2. Visual and Mechanical Inspection

   a. Compare equipment nameplate data with drawings and specifications.

   b. Inspect physical and mechanical condition.

   c. Inspect anchorage and alignment.

   d. Verify the unit is clean.

   e. Operate the circuit breaker to insure smooth operation.

   f. Inspect bolted electrical connections for high resistance using one or more of the following methods:

      1) Use of a low-resistance ohmmeter in accordance with section A3 below Electrical Tests.

      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

   g. Inspect operating mechanism, contacts, and arc chutes in unsealed units.

   h. Perform adjustments for final protective device settings in accordance with the coordination study.

3. Electrical Tests

   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with section A2 above Visual and Mechanical Inspection.

   b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to- ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1.

   c. Perform a contact/pole-resistance test.

   d. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute. For units with electronic components, follow manufacturer's recommendation.

   e. Determine long-time pickup and delay by primary current injection.

   f. Determine short-time pickup and delay by primary current injection.

   g. Determine ground-fault pickup and time delay by primary current injection.

   h. Determine instantaneous pickup by primary current injection.

   i. Test functions of the trip unit by means of secondary injection.

   j. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.

   k. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free,

anti-pump function, and trip unit battery condition. Reset all trip logs and indicators.

l. Verify operation of charging mechanism, where applicable.

4. Test Values

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

c. Final setting shall comply with approved coordination study. Complete test reports shall include final approved settings.

d. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If the manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.

e. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.

f. Insulation-resistance values of control wiring shall not be less than two megohms.

g. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS Table 100.7.

h. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.

i. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.

j. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, refer to NETA ATS Table 100.8 for magnetic trip values.

k. Pickup values and trip characteristics shall be within manufacturer's published tolerances.

l. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data. In the absence of the manufacturer's published data, refer to NETA ATS Table 100.20.

m. Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.

n. The charging mechanism, where applicable, shall operate in accordance with manufacturer's published data.

o. Update and insure settings programmed match those given in the approved power system study.

B. Grounding Systems

1. Inspect physical and mechanical conditions.
2. Verify ground system complies with the drawings, specifications, and CEC.
3. Verify that ground system installation is completed before performing testing work.
4. Use "3 probe - fall of potential" method or alternative test in accordance with ANSI/IEEE 80 on the main grounding electrode or system ground rods. All other ground tests may be measured to system ground by use of ground reference method or point-to-point between the main grounding system and all major electrical equipment frames, system neutral, an/or derived neutral points.
5. Tests include measurement of ground resistance at the following equipment and structures:
    a. All switchboards.
    b. All Power distribution panelboards.
    c. All power transformer frames and neutral grounds.
    d. Other miscellaneous grounds selected at random in a manner to be representative of the entire installation.
    e. Ground system ground rods, including those in manholes.
    f. Building frame.
    g. Isolated instrumentation system.
6. The main ground electrode system resistance to ground to be no greater than 5 ohms.
7. Main system grounds showing more than 5 ohms resistance to earth shall be identified and reviewed by the owner’s representative.
8. Investigate point-to-point resistance values which exceed 0.5 ohms.
9. Test main service entrance neutral systems to be free of grounding by temporarily removing the neutral to grounding bar and measuring to ground. Investigate resistance values less than 100 ohms.
10. Test any new derived neutral systems to be free of grounding by temporarily removing the neutral to grounding bar and measuring to ground. Investigate resistance values less than 100 ohms.

C. Cables, Low-Voltage, 600-Volt Maximum

1. Test all cables shown on the one-line drawings to assure proper installation, integrity, and connections in accordance with the Drawings, Specifications, and the manufacturer's recommendations.
2. Visual and Mechanical Inspection
    a. Compare cable data with drawings and specifications.
    b. Inspect exposed sections of cable for physical damage and correct connection in accordance with the single-line diagram.
    c. Inspect bolted electrical connections for high resistance using one or more of the following methods:
        1) Use of low-resistance ohmmeter in accordance with section C3 below Electrical tests.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

d. Inspect compression-applied connectors for correct cable match and indentation.

e. Inspect for correct identification and arrangements.

f. Inspect cable jacket insulation and condition.

3. Electrical Tests

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter, if applicable, in accordance section C2 above Visual and Mechanical.

b. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute.

c. Perform continuity tests to insure correct cable connection.

d. Verify uniform resistance of parallel conductors.

4. Test Values

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

c. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations or less than 50 megohms shall be investigated.

d. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

D. Cables, Medium and High-Voltage

1. Test all cables shown on the one-line drawings to assure proper installation and connections in accordance with the Drawings, Specifications, and the manufacturer's recommendations.

2. Visual and Mechanical Inspection

a. Compare cable data with drawings and specifications.

b. Inspect exposed sections of cable for physical damage and correct connection in accordance with the single-line diagram.

c. Inspect bolted electrical connections for high resistance using one or more of the following methods:

1) Use of low-resistance ohmmeter in accordance with section D3 below Electrical tests.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

d. Inspect compression-applied connectors for correct cable match and indentation.

e. Inspect shield grounding, cable supports, and terminations.

f. Verify that visible cable bends meet or exceed ICEA and manufacturer's minimum published bending radius.

g. If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

h. Inspect for correct cable identification and arrangements.

i. Inspect cable jacket insulation and condition.

3. Electrical Tests

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter, if applicable, in accordance section D2 above Visual and Mechanical.

b. Perform an insulation-resistance test individually on each conductor with all other conductors and shields grounded. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1.

c. Perform a shield-continuity test on each power cable.

d. In accordance with ICEA, IEC, IEEE and other power cable consensus standards, testing can be performed by means of direct current, power frequency alternating current, or very low frequency alternating current. These sources may be used to perform insulation-withstand tests, and baseline diagnostic tests such as partial discharge analysis, and power factor or dissipation factor. The selection shall be made after an evaluation of the available test methods and a review of the installed cable system. Some of the available test methods are listed below.

1) Dielectric Withstand

a) Direct current (dc) dielectric withstand voltage

b) Very low frequency (VLF) dielectric withstand voltage

c) Power frequency (50/60 Hz) dielectric withstand voltage

2) Baseline Diagnostic Tests

a) Power factor/ dissipation factor (tan delta)

b) Power frequency (50/60 Hz)

c) Very low frequency (VLF)

3) DC insulation resistance

4) Partial discharge

a) Online (50/60 Hz)

b) Off line

(1) Power Frequency (50/60 Hz)

(2) Very low frequency (VLF)

e. Perform continuity tests to insure correct cable connection.

f. Verify uniform resistance of parallel conductors.

4. Test Values

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

c. The minimum bend radius to which insulated cables may be bent for permanent training shall be in accordance with NETA ATS Table 100.22.

d. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations or less than 50 megohms shall be investigated.

e. Shielding shall exhibit continuity. Investigate resistance values in excess of ten ohms per 1000 feet of cable.

f. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the test, the test specimen is considered to have passed the test.

g. Based on the test methodology chosen, refer to applicable standards or manufacturer's literature for acceptable values.

h. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

E. Power Distribution Panelboard Assemblies, Lighting and appliance panelboards, Small Power Centers, and Enclosed Circuit Breakers:

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and required area clearances.

d. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.

e. Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breakers address for microprocessor-communication packages.

f. Verify that wiring connections are tight, and that wiring is secure to prevent damage during routine operation of any moving parts.

g. Inspect bolted electrical connections for high resistance using one or more of the following methods:

1) Use of a low-resistance ohmmeter in accordance with section E2 below Electrical Tests.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

h. Verify operation and sequencing of any breaker electrical and mechanical interlocking systems. Attempt to close a locked open device and attempt to open a locked closed device and again after exchange of sequencing breakers.

i. Inspect insulators for evidence of physical damage or contaminated surfaces.

j. On switchboards with more than one section verify section barriers are installed.

k. Exercise all active components.

l. Verify that filters are in place and/or vents are clear.

2. Electrical Tests

a. Perform resistance measurements through bolted electrical connections with a low-resistance ohmmeter, if applicable, in accordance section E1 above Visual and Mechanical Inspection.

b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute in accordance with NETA ATS Table 100.1. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

c. Perform ground-resistance tests from switchboard/panel to ground system.

d. Perform phasing checks on double-ended or dual-source switchgear to insure correct bus phasing from each source.

e. Verify operation of switchboard space heaters and thermostat control per each section for equipped switchboards.

3. Test Values – Visual and Mechanical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

4. Test Values – Electrical

a. Bolt-torque levels should be in accordance with NETA Table 100.12 unless otherwise specified by manufacturer.

b. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. Compare bolted connection resistance values to values of similar connections.

Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

c. Insulation-resistance values of bus insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.

d. Results of ground-resistance tests shall be in accordance with grounding testing section of this spec.

5. Perform visual and mechanical inspection and testing of instrument current and potential transformers and metering devices in accordance Electrical Power Metering Section 26 2713.

F. Electrical Power Metering

1. New Electrical Power Meters installed for this project shall be checked and tested per this specification and manufacturer's instructions.

2. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect meters and cases for physical damage.

c. Clean front panel and remove shipping restraint material.

d. Verify tightness of electrical connections.

e. Record model number, serial number, firmware revision, software revision, and rated control voltage.

f. Verify and record meter current and voltage transformer ratios and that they correspond to drawings.

g. Verify operation of display and indicating devices.

h. Record passwords.

i. Verify unit is grounded in accordance with manufacturer's instructions.

j. Verify unit is connected in accordance with manufacturer's instructions and project drawings. Verify proper voltage and current transformer ratios.

k. Verify control power to the meter is protected by an accessible disconnect fuse switch with CC fuses.

l. Verify sensing voltage to the meter is protected by 3 single phase accessible disconnect fuse switches with CC fuses for 3 phase or with 1 single accessible disconnect CC fuse for single phase monitoring.

m. Record all CC fuse amp ratings.

n. Verify that all current sensing to the meter is provided thru shorting terminal blocks.

o. Set and record all required parameters including instrument transformer ratios, system type and voltage, frequency, power demand methods/intervals, current time, date, and communications requirements along with IP address.

p. Provide support for establishing meter communications to owner power monitoring system. Meter shall communicate with owner utility monitoring system.

3. Electrical Tests

   a. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication. This should include phase checking so that wattage readings are not in reverse and not less then what is expected. All phase should add to wattage total and not be negative readings for some phases.

   b. Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.

   c. After initial system energization, confirm measurements and indications are consistent with loads present. Confirm readings using a secondary portable meter.

4. Test Values

   a. Nameplate data shall be per drawings and specifications.

   b. Tightness of electrical connections shall ensure a low resistance connection.

   c. Display and indicating devices shall operate per manufacturer's published data.

   d. Measurement and indication of applied values of voltage and current shall be within manufacturer's published tolerances for accuracy.

   e. All auxiliary input/output features shall operate per settings and manufacturer's published data.

   f. Measurements and indications shall be consistent with energized system loads.

   g. Wattage readings should not be in reverse and not less then what is expected. All phases should add to wattage total and not be negative readings for some phases.

G. Switchgear and Switchboard Assemblies

1. Visual and Mechanical Inspection

   a. Compare equipment nameplate data with drawings and specifications.

   b. Inspect physical and mechanical condition.

   c. Inspect anchorage, alignment, grounding, and required area clearances.

   d. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.

   e. Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breakers address for microprocessor-communication packages.

   f. Verify that current and voltage transformer ratios correspond to drawings.

   g. Verify that wiring connections are tight, and that wiring is secure to prevent damage during routine operation of moving parts.

   h. Inspect bolted electrical connections for high resistance using one or more of the following methods:

      1) Use of a low-resistance ohmmeter in accordance with Section H2 below Electrical Tests.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or corresponding NETA ATS Table.

i. Verify operation and sequencing of interlocking systems.

j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

k. Inspect insulators for evidence of physical damage or contaminated surfaces.

l. Verify correct barrier and shutter installation and operation, including arc flash exhaust chutes.

m. Exercise all active components.

n. Inspect mechanical indicating devices for correct operation.

o. Verify that filters are in place and vents are clear.

p. Perform visual and mechanical inspection of instrument transformers in accordance with Section H1 above Visual and Mechanical Inspection.

q. Perform visual and mechanical inspection of surge arresters in accordance with Section H1 above Visual and Mechanical Inspection.

r. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse or circuit breaker ratings match drawings.

3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

2. Electrical Tests

a. Perform resistance measurements through bolted electrical connections with a low-resistance ohmmeter, if applicable.

b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute in accordance with corresponding NETA ATS Table.

c. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it shall be in accordance with corresponding NETA ATS Table. The test voltage shall be applied for one minute.

d. Perform electrical tests on instrument transformers.

e. Perform ground-resistance tests.

f. Determine accuracy of all meters and calibrate watthour meters. Verify multipliers.

g. Control Power Transformers

1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages

shall be in accordance with corresponding NETA ATS unless otherwise specified by the manufacturer.

2) Perform a turns-ratio test on all tap positions.

3) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.

4) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

5) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.

h. Voltage Transformers

1) Perform secondary wiring integrity test. Verify correct potential at all devices.

2) Verify secondary voltages by energizing the primary winding with system voltage.

i. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 ampere flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

j. Perform system function tests in accordance with NETA ATS section System Function Tests.

k. Verify operation of cubicle switchgear/switchboard space heaters.

l. Perform phasing checks on double-ended or dual-source switchgear to insure correct bus phasing from each source.

m. Perform electrical tests of surge arresters in accordance with NETA ATS section Surge Arresters.

3. Test Values – Visual and Mechanical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

4. Test Values – Electrical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Insulation-resistance values of bus insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table. Values of insulation resistance less than this table or manufacturer's recommendations should

be investigated. Dielectric withstand voltage tests shall not proceed until insulation-resistance levels are raised above minimum values.

c. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

d. Minimum insulation-resistance values of control wiring shall not be less than two megohms.

e. Results of electrical tests on instrument transformers shall be in accordance with NETA ATS section Instrument Transformers.

f. Results of ground-resistance tests shall be in accordance with NETA ATS section Grounding Systems.

g. Accuracy of meters shall be in accordance with NETA ATS section Metering Devices.

h. Control Power Transformers

1) Insulation-resistance values of control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.

2) Turns-ratio test results shall not deviate by more than one-half percent from either

3) Secondary wiring shall be in accordance with design drawings and specifications.

4) Secondary voltage shall be in accordance with design specifications.

5) Control transfer relays shall perform as designed.

i. Voltage transformers

1) Secondary wiring shall be in accordance with design drawings and specifications.

2) Secondary voltage shall be in accordance with design specifications

j. Current-injection tests shall prove current wiring is in accordance with design specifications.

k. Results of system function tests shall be in accordance with NETA ATS section System Function Tests.

l. Heaters shall be operational.

m. Phasing checks shall prove the switchgear or switchboard phasing is correct and in accordance with the system design.

H. Transformers, Liquid-Filled

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, and grounding.

d. Verify the presence of PCB content labeling.

e. Verify removal of any shipping bracing after placement.

f. Verify the bushings are clean.

g. Verify that alarm, control, and trip settings on temperature and level indicators are as specified, if applicable.

h. Verify operation of alarm, control, and trip circuits from temperature and level indicators, pressure relief device, gas accumulator, and fault pressure relay, if applicable.

i. Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection, if applicable.

j. Inspect bolted electrical connections for high resistance using one or more of the following methods:

1) Use of a low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or corresponding NETA ATS Table.

k. Verify correct liquid level in tanks and bushings, if applicable.

l. Verify that positive pressure is maintained on gas-blanketed transformers.

m. Perform inspections and mechanical tests as recommended by the manufacturer.

n. Test load tap-changer.

o. Verify presence of transformer surge arresters, if specified for transformer.

p. Verify de-energized tap-changer position is left as specified.

2. Electrical Tests

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter if applicable.

b. Perform insulation-resistance tests, winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table. Calculate polarization index.

c. Perform turns-ratio tests at all tap positions.

d. Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer's published data.

e. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/ capacitance tap. In the absence of a power-factor/ capacitance tap, perform hot-collar tests. These tests shall be in accordance with the test equipment manufacturer's published data.

f. Perform excitation-current tests in accordance with test equipment manufacturer's published data.

g. Measure the resistance of each high-voltage winding in each de-energized tap-changer position.

h. Measure the resistance of each low-voltage winding in each de-energized tap-changer position, if applicable.

i. Remove a sample of insulating liquid in accordance with ASTM D 923. Sample shall be tested for the following.

1) Dielectric breakdown voltage: ASTM D 877 and/or ASTM D 1816

2) Acid neutralization number: ANSI/ASTM D 974

3) Interfacial tension: ANSI/ASTM D 971 or ANSI/ASTM D 2285

4) Color: ANSI/ASTM D 1500

5) Visual Condition: ASTM D 1524

j. Remove a sample of insulating liquid in accordance with ASTM D 3613 and perform dissolved-gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ASTM D3612.

k. Test instrument transformers in accordance with NETA ATS section Instrument Transformers, where applicable.

l. Test surge arresters, if present.

m. Test transformer neutral grounding impedance device, if present.

3. Test Values – Visual and Mechanical

a. Alarm, control, and trip circuits from temperature and level indicators as well as pressure relief device and fault pressure relay shall operate within manufacturer's recommendations for their specified settings.

b. Cooling fans and pumps shall operate upon reaching setpoint.

c. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

d. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

e. Liquid levels in the transformer tanks and bushings shall be within indicated tolerances.

f. Positive pressure shall be indicated on pressure gauge for gas-blanketed transformers.

4. Test Values – Electrical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Minimum insulation-resistance values of transformer insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated. The polarization index shall not be less than 1.0.

c. Turns-ratio test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio.

d. Maximum winding insulation power-factor/dissipation-factor values of liquid-filled transformers shall be in accordance with the manufacturer's published data. In the absence of manufacturer's published data use corresponding NETA ATS Table.

e. Investigate bushing power-factor and capacitance values that vary from nameplate values by more than ten percent. Hot-collar tests are evaluated on a milliampere/milliwatt loss basis, and the results should be compared to values of similar bushings.

f. Typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading.

g. Temperature corrected winding-resistance values shall compare within one percent of previously obtained results.

h. Core insulation values shall be compared to the factory test value but not less than one megohm at 500 volts dc.

i. Investigate the presence of oxygen in the nitrogen gas blanket.

j. Insulating liquid values shall be in accordance with Table 100.4.

k. Evaluate results of dissolved-gas analysis in accordance with ANSI/IEEE Standard C57.104.

l. Results of electrical tests on instrument transformers shall be in accordance with NETA ATS section Instrument Transformers.

m. Results of surge arrester tests shall be in accordance with NETA ATS section Surge Arresters.

I. Circuit Breakers, Vacuum, Medium-Voltage

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, and grounding.

d. Verify that all maintenance devices such as special tools specified by the manufacturer are available for servicing and operating the breaker.

e. Verify the unit is clean.

f. Perform all mechanical operation tests on the operating mechanism in accordance with manufacturer's published data.

g. Measure critical distances such as contact gap as recommended by manufacturer.

h. Inspect bolted electrical connections for high resistance using one or more of the following methods:

1) Use of low-resistance.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or corresponding NETA ATS Table.

i. Verify cell fit and element alignment.

j. Verify racking mechanism operation.

k. Record as-found and as-left operation counter readings.

2. Electrical Tests

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to- ground with the circuit breaker closed, and across each open pole. Test voltage shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

c. Perform a contact/pole-resistance test.

d. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data.

e. Verify correct operation of any auxiliary features such as electrical close and trip operation, trip-free, and antipump function.

f. Trip circuit breaker by operation of each protective device. Reset all trip logs and indicators.

g. Perform vacuum bottle integrity (dielectric withstand voltage) test across each vacuum bottle with the breaker in the open position in strict accordance with manufacturer's published data.

h. Perform a dielectric withstand voltage test in accordance with manufacturer's published data.

i. Verify operation of heaters.

j. Test instrument transformers in accordance with NETA ATS section Instrument Transformers.

3. Test Values – Visual and Mechanical

a. Critical distance measurements such as contact gap shall be in accordance with the manufacturer's published data.

b. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

c. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

d. Travel and velocity values shall be in accordance with manufacturer's published data.

e. Operation counter shall advance one digit per close-open cycle.

4. Test Values – Electrical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Insulation-resistance values of circuit breakers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.

c. Insulation-resistance values of control wiring shall not be less than two megohms.

d. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. In the absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.

e. Minimum pickup voltage of the trip and close coils shall conform to the manufacturer's published data. In the absence of the manufacturer's published data, refer to corresponding NETA ATS Table.

f. Auxiliary features shall operate in accordance with manufacturer's published data.

g. Protective devices shall operate the breaker per system design.

h. Power-factor or dissipation-factor values shall be compared to manufacturer's published data.

i. In the absence of manufacturer's published data, the comparison shall be made to similar breakers.

j. Power-factor or dissipation-factor and capacitance values shall be within ten percent of nameplate rating for bushings. Hot collar tests are evaluated on a milliampere/milliwatt loss basis, and the results should be compared to values of similar bushings.

k. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.

l. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

m. Heaters shall be operational.

n. Results of instrument transformer tests shall be in accordance with NETA ATS section Instrument Transformer.

J. Protective Relays, Microprocessor-Based

1. Visual and Mechanical Inspection

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.

b. Verify operation of light-emitting diodes, display, and targets.

c. Clean the front panel and remove foreign material from the case.

d. Check tightness of connections.

e. Verify that the frame is grounded in accordance with manufacturer's instructions.

f. Set the relay in accordance with the coordination study.

g. Download settings from the relay and compare the settings to those specified in the coordination study or site documentation.

h. Connect backup battery, if applicable.

i. Set clock and date if not controlled externally.

2. Electrical Tests

a. Perform insulation-resistance tests from each circuit to the grounded frame in accordance with manufacturer's published data.

b. Upload relay setting data files provided from relay Power System SCADA integrator. Verify correct file upload and configuration of all settings. Ensure all settings are configured correctly, or disabled if not needed for the relay application.

c. Apply voltage or current to all analog inputs and verify correct registration of the relay meter functions.

d. Functional Operation

1) Check functional operation of each element used in the protection scheme as described for electronic relays. When not otherwise specified, use manufacturer's recommended tolerances.

e. Control Verification

1) Functional tests

a) Check operation of all active digital inputs.

b) Check all output contacts or SCRs, preferably by operating the controlled device such as circuit breaker, auxiliary relay, or alarm.

c) Check all internal logic functions used in the protection scheme.

d) Upon completion of testing, reset all min/max recorders, communications statistics, fault counters, sequence of events recorder, and all event records.

2) In-service monitoring

a) After the equipment is initially energized, measure magnitude and phase angle of all inputs and compare to expected values.

K. Instrument Transformers

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Verify correct connection of transformers with system requirements.

d. Verify that adequate clearances exist between primary and secondary circuit wiring.

e. Verify the unit is clean.

f. Inspect bolted electrical connections for high resistance using one or more of the following methods:

1) Use of low-resistance meter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or corresponding NETA ATS Table.

g. Verify that all required grounding and shorting connections provide contact.

h. Verify correct operation of transformer withdrawal mechanism and grounding operation.

i. Verify correct primary and secondary fuse sizes for voltage transformers.

j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests - Current Transformers

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable.

b. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 volts dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer’s recommendations.

c. Perform a polarity test of each current transformer in accordance with ANSI/IEEE C57.13.1.

d. Perform a ratio-verification test using the voltage or current method in accordance with ANSI/IEEE C57.13.1.

e. Perform an excitation test on transformers used for relaying applications in accordance with ANSI/IEEE C57.13.1.

f. Measure current circuit burdens at transformer terminals in accordance with ANSI/IEEE C57.13.1.

g. When applicable, perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages shall be in accordance with Table 100.5.

h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.

i. Verify that current transformer secondary circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3. That grounding point should be located as specified by the engineer in the project drawings.

3. Electrical Tests - Voltage Transformers

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Section 7.10.1.

b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages shall be applied for one minute in accordance with Table 100.5. For units with solid- state components that cannot tolerate the applied voltage, follow manufacturer’s recommendations.

c. Perform a polarity test on each transformer to verify the polarity marks or H1- X1 relationship as applicable.

d. Perform a turns-ratio test on all tap positions.

e. Measure voltage circuit burdens at transformer terminals.

f. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.

g. Verify that voltage transformer secondary circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3. The grounding point should be located as specified by the engineer in the project drawings.

4. Electrical Tests - Coupling-Capacitor Voltage Transformers

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Section 7.10.1.

b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages shall be applied for one minute in accordance with Table 100.5. For units with solid- state components that cannot tolerate the applied voltage, follow manufacturer's recommendations.

c. Perform a polarity test on each transformer to verify the polarity marking. See ANSI/IEEE C93.1 for standard polarity marking.

d. Perform a turns-ratio test on all tap positions, if applicable.

e. Measure voltage circuit burdens at transformer terminals.

f. Measure capacitance of capacitor sections.

g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.

h. Verify that the coupling-capacitor voltage transformer circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3. That grounding point should be located as specified by the engineer in the project drawings.

5. Test Values – Visual and Mechanical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

6. Test Values – Current Transformers – Electrical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Insulation-resistance values of instrument transformers shall not be less than values shown in corresponding NETA ATS Table.

c. Polarity results shall agree with transformer markings.

d. Ratio errors shall be in accordance with C57.13.

e. Excitation results shall match the curve supplied by the manufacturer or be in accordance with ANSI C57.13.1.

f. Measured burdens shall be compared to instrument transformer ratings.

g. Insulation-resistance values of instrument transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

h. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.

i. Power-factor or dissipation-factor values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.

j. Test results shall indicate that the circuits have only one grounding point.

7. Test Values –Voltage Transformers – Electrical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Insulation-resistance values of instrument transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

c. Polarity results shall agree with transformer markings.

d. Ratio errors shall be in accordance with C57.13.

e. Measured burdens shall be compared to instrument transformer ratings.

f. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary windings are considered to have passed the test.

g. Power-factor or dissipation-factor values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.

h. Test results shall indicate that the circuits are grounded at only one point.

8. Test Values – Coupling Capacitor Voltage Transformers

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Insulation-resistance values of instrument transformers shall not be less than values shown in Table 100.5.

c. Polarity results shall agree with transformer markings.

d. Ratio errors shall be in accordance with C57.13.

e. Measured burdens shall be compared to instrument transformer ratings.

f. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

g. Capacitance of capacitor sections of coupling-capacitor voltage transformers shall be in accordance with manufacturer's published data.

h. Power-factor or dissipation-factor values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.

i. Test results shall indicate that the circuits are grounded at only one point.

L. Enclosed Switches – Low Voltage

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and required clearances.

d. Verify the unit is clean.

e. Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.

f. Verify that fuse sizes and types are in accordance with drawings, short-circuit studies, and approved coordination study.

g. Verify that each fuse has adequate mechanical support and contact integrity.

h. Inspect bolted electrical connections for high resistance using one of the following methods.

1) Use of low-resistance ohmmeter in accordance with Section I2 below Electrical Tests.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

i. Verify operation and sequencing of door interlocking system.

j. Verify correct phase barrier installation.

k. Verify correct operation of all indicating devices.

2. Electrical Test

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Section I1 above Visual and Mechanical Inspection.

b. Measure contact-resistance across each switchblade and fuseholder.

c. Measure fuse resistance.

3. Test Values

a. Compare bolted connection resistances to values of similar connections.

b. Bolt-torque levels should be in accordance with NETA ATS Table 100.12 unless otherwise specified by the manufacturer.

c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. Investigate any values which deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

M. Direct-Current Systems, Batteries, Valve-Regulated Lead-Acid, Ni-Cd

1. Visual and Mechanical Inspection

a. Verify that batteries are adequately located.

b. Verify that battery area ventilation system is operable.

c. Verify existence of suitable eyewash equipment.

d. Compare equipment nameplate data with drawings and specifications.

e. Inspect physical and mechanical condition.

f. Verify adequacy of battery support racks or cabinets, mounting, anchorage, alignment, grounding, and clearances.

g. Verify the units are clean.

h. Verify the application of an oxide inhibitor on battery terminal connections.

i. Inspect bolted electrical connections for high resistance using one or more of the following methods:

1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table.

2. Electrical Tests

a. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable.

b. Measure negative post temperature.

c. Measure charger float and equalizing voltage levels.

d. Verify all charger functions and alarms.

e. Measure each monoblock/cell voltage and total battery voltage with charger energized and in float mode of operation.

f. Measure intercell connection resistances.

g. Perform internal ohmic measurement tests.

h. Perform a load test in accordance with manufacturer's published data or ANSI/IEEE 1188.

i. Measure the battery system voltage from positive to ground and negative to ground.

3. Test Values – Visual and Mechanical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

4. Test Values – Electrical

a. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Negative post temperature shall be within manufacturer's published data or IEEE 1188.

c. Charger float and equalize voltage levels shall be in accordance with the battery manufacturer's published data.

d. Results of charger functions and alarms shall be in accordance with manufacturer's published data.

e. Monoblock/cell voltages shall be in accordance with manufacturer's published data.

f. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

g. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) shall not vary by more than 25 percent between identical monoblocks/cells in a fully charged state.

h. Results of load tests shall be in accordance with manufacturer's published data or IEEE 1188.

i. Voltage measured from positive to ground shall be similar in magnitude to the voltage measured from negative to ground.

N. Direct-Current Systems, Chargers

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect for physical and mechanical condition.

c. Inspect anchorage, alignment, and grounding.

d. Verify the unit is clean.

e. Inspect all bolted electrical connections for high resistance using one or more of the following methods:

1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or corresponding NETA ATS Table.

f. Inspect filter and tank capacitors.

g. Verify operation of cooling fans and presence of filters.

2. Electrical Tests

a. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable.

b. Verify float voltage, equalize voltage, and high voltage shutdown settings.

c. Verify current limit.

d. Verify charger operates and maintains loads energized while batteries are taken out of service.

e. Verify calibration of meters in accordance with Section 7.11.

f. Verify operation of alarms and contacts activated by alarm, including low-voltage alarms.

g. Measure and record input and output voltage and current.

h. Measure and record ac ripple current and voltage imposed on the battery.

3. Test Values – Visual and Mechanical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

4. Test Values – Electrical

a. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Float and equalize voltage settings shall be in accordance with the battery manufacturer's published data.

c. Current limit shall be within manufacturer's recommended maximum.

d. Results of load sharing between parallel chargers shall be in accordance with system design specifications.

e. Results of meter calibration shall be in accordance with NETA ATS section Metering Devices.

f. Results of alarm operation shall be in accordance with manufacturer's published data and system design.

g. Input and output voltage shall be in accordance with manufacturer's published data.

h. AC ripple current and voltage imposed on the battery shall be in accordance with manufacturer's published data.

i. Charger shall be capable of manufacturer's specified full load.

O. Emergency Systems, Uninterruptible Power Systems, Inverters

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and required clearances.

d. Verify that fuse sizes and types correspond to drawings.

e. Verify the unit is clean.

f. Test all electrical and mechanical interlock systems for correct operation and sequencing.

g. Inspect bolted electrical connections for high resistance using one or more of the following methods:

1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or corresponding NETA ATS Table.

h. Verify operation of forced ventilation.

i. Verify that filters are in place and vents are clear.

2. Electrical Tests

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable.

b. Test static transfer from inverter to bypass and back. Use normal load, if possible.

c. Set free running frequency of oscillator.

d. Test dc undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.

e. Test alarm circuits.

f. Verify synchronizing indicators for static switch and bypass switches.

g. Perform electrical tests for UPS system breakers in accordance with NETA ATS section Circuit Breakers.

h. Perform electrical tests for UPS system automatic transfer switches in accordance with NETA ATS section Emergency Systems, Automatic Transfer Switches.

i. Perform electrical tests for UPS system batteries in accordance with NETA ATS section Direct-Current Systems.

j. Perform electrical tests for UPS rotating machinery in accordance with NETA ATS section Rotating Machinery.

3. Test Values – Visual and Mechanical

a. Electrical and mechanical interlock systems shall operate in accordance with system design requirements.

b. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

c. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use corresponding NETA ATS Table.

4. Test Values – Electrical

a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Static transfer shall function in accordance with manufacturer's published data.

c. Oscillator free running frequency shall be within manufacturer's published tolerances.

d. DC undervoltage shall trip inverter input breaker.

e. Alarm circuits shall operate in accordance with design requirements.

f. Synchronizing indicators shall operate in accordance with design requirements.

g. Breaker performance shall be in accordance with NETA ATS section Circuit Breakers.

h. Automatic transfer switch performance shall be in accordance with NETA ATS section Emergency Systems, Automatic Transfer Switches.

i. Battery test results shall be in accordance with NETA ATS section Direct-Current Systems.

j. Rotating machinery performance shall be in accordance with NETA ATS section Rotating Machinery.

P. Fiber-Optic Cables

1. Visual and Mechanical Inspection

a. Compare cable, connector, and splice data with drawings and specifications.

b. Inspect cable and connections for physical and mechanical damage.

c. Verify that all connectors and splices are correctly installed.

2. Optical Tests

a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer.

b. Perform connector and splice integrity test using an optical time domain reflectometer.

c. Perform cable attenuation loss measurement with an optical power loss test set.

d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set.

3. Test Values – Visual and Mechanical

a. Cable and connections shall not have been subjected to physical or mechanical damage.

b. Connectors and splices shall be installed in accordance with industry standards.

4. Test Values – Optical

a. The optical time domain reflectometer signal shall be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.

b. The optical time domain reflectometer signal shall be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.

c. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer’s recommendations when no local site specifications are available.

d. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer’s recommendations when no local site specifications are available.

e. Each fiber cable shall be labeled matching the identification number used for testing each fiber cable strand. For example, cable 2 identified in the test report shall be labeled “2”. Test Contractor shall provide labeling for

each fiber optic cable in a multi-stand cable with identification matching fiber optic cable test report.

3.03 THERMOGRAPHIC TECHNICAL REQUIREMENTS

A. After all acceptance tests are completed and approved, system is energized with load, at one or two weeks before notice of project work completion, perform thermographic survey testing for all new electrical system components installed for this project, and including all existing electrical system components that are interconnected of the following with as much system load energized as possible:

1. Cables, Low-Voltage, 600-Volt Maximum.
2. Cables, Medium and High-Voltage.
3. Power Distribution Panelboard Assemblies, Lighting and appliance panelboards, Small Power Centers, and Enclosed Circuit Breakers.
4. Pad-Mounted, Liquid-Filled, Medium - Voltage Transformers.
5. Enclosed Switches – Low Voltage.
6. Automatic Transfer Switch.
7. Junction modules in tunnel.

B. Survey shall include all current-carrying devices.

C. Visual and Mechanical Inspection

1. Perform thermographic survey when load is applied to the system.
2. Remove all necessary covers prior to thermographic inspection. Use appropriate caution, safety devices, and personal protective equipment.

D. Test Parameters

1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.
2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.

E. Test Results

1. Suggested actions based on temperature rise can be found in NETA ATS Table 100.18.

3.04 RETESTING

A. Retest any equipment which does not pass initial tests after correction is made, or where subsequent testing is required for acceptance as directed by the Owner’s Representative.

3.05 REPLACEMENT OF DEFECTIVE MATERIAL OR EQUIPMENT

A. Repair or replace any material or equipment found defective or cannot pass the tests specified in this Section at no additional cost to the Owner.

B. Complete correction of defective material or equipment and retesting within the Contract period.

C. If the equipment or material cannot pass the second test, remove the defective equipment and replace it with equivalent equipment that meets the requirements of the Specifications. Such replacement shall be at no cost to the Owner.

D. Remove defective equipment or material from the site no later than 15 days from the date of notification by the Owner or Owner's Representative.

3.06 FIELD ADJUSTMENTS TECHNICAL REQUIREMENTS

A. Testing firm is responsible to apply final setting and adjustments on protective devices in accordance with values from the approved coordination study. Submit complete test reports that include final approved settings.

END OF SECTION

SECTION 26 0801 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. California Electrical Code (CEC) most recent addition adopted by Authority Having Jurisdiction, including all applicable amendments and supplements, as based on NFPA 70.

C. California Green Building Standards Code (CBSC), Part II, Title 24.

1.02 REFERENCES

A. National Electrical Testing Association (NETA)

B. American National Standard Institute (ANSI)

C. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Guideline 0-213

D. Institute of Electrical and Electronic Engineers (IEEE)

E. California Electrical Code (CEC)

F. California Energy Commission (CEC)

G. Building Commissioning Association (BCA)

H. AABC Commissioning Group (ACG)

1.03 SUMMARY

A. This Section describes the requirements for start-up and commissioning for Division 26 and Division 27 installed work.

B. Specific functional performance testing procedures for individual systems, as they are developed throughout the course of the project, will be distributed as part of a separate commissioning plan document.

C. The work includes commissioning support activities for the Electrical Distribution Replacement project, including but not limited to the following Contractor responsibilities:

1. Provide technical information, as part of the normal submittal process, as designs are finalized and as equipment is selected.

2. Provide copies of Requests for Interpretation and formal Contractor Contract Modifications for inclusion in the test procedure support information. The body of the RFI or Contract Modification will be included as a part of the test procedure as needed for clarity. Also provide copies of documents that pertain to modification of the commissioned systems.

3. Write test procedures for review by the Owner. Ensure that the test procedures are feasible, complete, and sufficient to demonstrate compliance with the requirements of the specifications. Submit test procedures for each system and include a line item for each associated device.

4. Provide personnel to support the commissioning effort.
    a. Designate a Commissioning Coordinator with administrative responsibility for scheduling and coordinating support of the Contractor's project commissioning responsibilities.
    b. Designate a Discipline Test Engineer for each system that will be tested, each of whom is fully familiar with the system to be tested. Each Test Engineer shall collaborate with the Project Commissioning Agent during the preparation of the testing procedures and shall have the responsibility of conducting and documenting the tests for that system.
    c. Retain the services of CALCTP field technician to complete lighting system controls acceptance testing, commissioning, and certification.
    d. Provide additional personnel who are familiar with each system, as needed, to efficiently conduct and document the commissioning tests.
5. Conduct and document the results of pre-functional tests and preliminary functional performance tests for verification. Correct deficiencies and make adjustments as needed.
6. Create training plans and submit the course outlines and classroom material for review by the Owner's Project Manager.
7. Transmit weekly reports to the Owner's Project Manager that include all of the pre-functional test results and functional performance test results.
    a. Computerized test reports, prepared by the Test Engineer, shall be the primary testing report mechanism.
    b. Hand annotated reports, produced for field convenience, shall be the secondary testing report mechanism.
8. Transmit a Letter of Completion for each system once that system is completely installed and proven fully functional, as documented in the pre-functional test results and the preliminary functional test results.
9. Conduct formally scheduled Functional Performance Test demonstrations for each system, for observation by the Project Commissioning Agent and other parties, to confirm that the system is compliant with the specifications and is available for beneficial usage. Transmit the demonstration functional performance test report to the Project Commissioning Agent on the day following the demonstration.
10. Review the subsequent commissioning report for each system, prepared by the Project Commissioning Agent as each system demonstration is completed, to ensure that the commissioning report accurately reflects the status of each reported system.
11. Include the related commissioning reports in the Maintenance Manual for each Section of the Project Closeout Documentation required for this project.
12. The entire Commissioning process may be completed using a web-based software application and may require the Contractor and its Commissioning Team to complete all work via the web and complete field testing with a laptop as a means of collecting data and providing the required results to the Owner's and the Project's Commissioning Agent.
13. Retain the services of an independent third-party Project Commissioning Agent (CxA), acceptable to the Owner, to execute the duties and responsibilities described in this section.

D. Related Work by the independent Project Commissioning Agent (CxA); the responsibilities of the commissioning agent include:

1. Preparation of the Commissioning Plan.
2. Preparation of the various commissioning related specifications.
3. Preparation of the pre-functional test procedures and the functional performance test procedures.
4. Preparation of test report templates that the Test Engineer(s) can fill-in and replicate for use as the permanent record including:
    a. Databases and spreadsheets that are intended for the direct and immediate entry of field observations and related reports.
    b. Printable documents that are intended for the hand annotation of field observations.
    c. Self-reporting by automated test instrumentation and computerized system diagnostics will be utilized where it is available and appropriate.
5. Observation of selected pre-functional tests.
    a. Review of all transmitted pre-functional test results.
6. Observation of selected preliminary functional performance tests.
    a. Review of all transmitted functional performance test results.
7. Review of other commissioning related documents that are transmitted.
8. Observation of all formally scheduled Functional Performance Test demonstrations.
    a. Review of all formally scheduled functional performance test demonstration results, and submittal of an associated Commissioning Report, for approval.
9. Advising the Owner regarding the functionality of tested systems, and their potential availability for beneficial usage.

1.04 ABBREVIATIONS AND DEFINITIONS

A. Abbreviations

1. CxA: Project Commissioning Agent
2. FPT: Functional Performance Test
3. PFT: Pre-functional Test
4. OPM: Owner’s Project Manager
5. CALCTP: California Advanced Lighting Controls Acceptance Testing

B. Definitions

1. Acceptance Phase: An industry term for the phase of construction, after installation and pre-functional testing, when functional performance testing occurs. These activities are often called startup.
2. Approval: meaning that the Owner has reviewed the submitted document for compliance with the contract documents.
    a. For Action submittals, the work may proceed.
    b. For Informational submittals, the work is satisfactory.

3. Basis of Design: The basis of design sets forth the primary thought processes and assumptions behind the decisions that are expressed in the criteria documents.

4. Project Commissioning Agent (CxA): An independent third-party entity approved by the Owner who is separately engaged by the Contractor which reviews design documents, writes the test procedures, participates in the day-to-day commissioning activities, observes formally scheduled Functional Performance Test demonstrations, collates the test results, and submits the final Commissioning Report for each system. This person is an independent, impartial third-party consultant who is responsible to report to both the Contractor and the Owner.

5. Commissioning Coordinator: The person, usually a member of the Contractor management team, who is responsible for scheduling commissioning activities including tests, ensuring that deficiencies are corrected, and scheduling retests.

6. Commissioning Plan: An overall plan that provides the structure, sequence, and coordination planning for the commissioning process.

7. Deferred Functional Performance Tests: Functional Performance Tests that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed as a part of the related tests.

8. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents.

9. Design Intent: The preferred term is Owner's Project Requirements. A dynamic document that provides an explanation of the ideas, concepts and criteria that are considered to be very important to the Owner. It is initially the outcome of the programming and conceptual design phases.

10. Design Narrative or Design Documentation: Sections of either the Design Intent or Basis of Design.

11. Factory Testing: Testing of equipment by factory authorized personnel, with an Owner's representative present.

12. Functional Performance Test (FPT): A test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods.

13. Manual Test: Using hand-held instruments, immediate control system readouts, or direct observation to verify performance, as contrasted to analyzing monitored data taken over time to obtain the data.

14. Monitor: Record performance parameters during equipment operation using either the inherent logging capabilities of a control system or else a separate data logger.

15. Non-Compliance: see Deficiency.

16. Non-Conformance: see Deficiency.

17. Owner-Contracted Tests: Tests paid for by the Owner outside of the Contractor's contract.

18. Phased Commissioning: Commissioning that is completed in phases (by substation, for example) due to availability, completion, or other scheduling issues, in order to minimize the total construction time.

19. Pre-functional Checklist (PC): An industry term for a portion of a Pre-Functional Test, specifically the list of items to inspect and the elementary component tests to conduct to verify proper installation of equipment.

20. Pre-functional Tests (PFT): Component and equipment tests conducted by the Test Engineer, including the Pre-Functional Checklist.

21. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment, during a particular test.

22. Seasonal Functional Performance Tests: Functional Performance Tests that are deferred until the system(s) will experience environmental conditions closer to their design conditions.

23. Shop Test: A type of pre-functional test that occurs in the subcontractor's shop, before the equipment is approved for delivery to the site. A shop test uses simulated field devices to demonstrate the routine operational modes of a control subsystem.

24. Simulated Condition: A condition that is created for the purpose of testing the response of a system (e.g., applying computer generated signals to represent door lock and position indicator switch positions).

25. Specifications: The design specifications prepared by the Engineer.

26. Startup: An industry term for the initial starting or activating of dynamic equipment, including the use of pre-functional checklists.

27. System Integrator: An industry term for a subcontractor who has a significant technical capability for dealing with complex electronic systems and programmable devices.

28. Subcontractor: The subcontractors to the Contractor, typically mechanical, electrical, and low voltage subcontractors, who provide and install system components and commissioned systems.

29. Test Engineer: (Also Discipline Test Engineer) The person, often the lead designer for the system or a key system integrator technician, who is the designated expert for a system or a few related systems. The Test Engineer collaborates with the commissioning agent during the preparation of test procedures, actually conducts the tests with the support of subcontractor personnel and is responsible for documenting and forwarding the test results to the Project Commissioning Agent.

30. Test Procedure: The step-by-step process that must be executed to fulfill the test requirements. The Project Commissioning Agent, in collaboration with the Test Engineer and subcontractor personnel who will be performing the tests, develops the pre-functional test procedures and functional performance test procedures.

31. Test and Certification Requirements: Requirements specifying the modes and functions, etc. that shall be tested. The test requirements are not the detailed test procedures, rather the test requirements are specified in the criteria specifications and documents and are further developed by the Engineer. These include manufacturer's, NETA, and CEC requirements for post installation acceptance testing, and CALCTP certification prior to energization.

32. Vendor: Supplier of equipment.

1.05 ADMINISTRATIVE

A. General descriptions of the commissioning roles are as follows:

1. Owner: Supports the commissioning process and gives final approval of the Commissioning work.

2. Owner's Project Manager: Acts on behalf of the Owner, tracks RFIs, Contract Modifications, and construction progress, approves submittals including test plans, and approves the Commissioning Reports.

3. Project Commissioning Agent: An independent third-party contracted by the Contractor who facilitates the commissioning process, writes test procedures, observes pre-functional tests and functional performance tests, reviews weekly test documents, and submits the system commissioning reports.
4. Architect/Engineer (A&E): The design portion of the Contractor's team responsible for resolution of technical and design issues encountered and discovered during the commissioning process.
5. Contractor: Integrates commissioning into the construction schedules, tracks RFIs and Contract Modifications, and ensures that the subcontractors comply with commissioning requirements.
6. Commissioning Coordinator: Schedules all commissioning-related activities for the Contractor including testing, and ensures that RFIs and Contract Modifications are reflected in the commissioning work.
7. Test Engineer: Collaborates with the commissioning agent during the development of the testing procedures, conducts the tests, and documents the results of the tests. There will usually be a different Test Engineer for each system. Depending on the system, the Test Engineer may be a member of the Engineering team, a key subcontractor technician, or a member of a testing firm.
8. Subcontractor: Installs the equipment and provides technical personnel who perform the tests that demonstrate compliance with the specifications and drawings.
9. Manufacturer: The equipment suppliers and vendors provide documentation to facilitate the commissioning work and often perform portions of the commissioning tests.

B. Commissioning support shall give due consideration, but not be limited to:

1. The functionality described in the specifications.
2. Tests that are required by regulatory agencies and code authorities.
3. The make and model of Owner selected equipment, devices, and elements.
4. The make and model of contractor selected equipment, devices, and elements, as indicated in product data submittals.
5. Tests that are recommended by the selected manufacturer.
6. Tests that are recommended by Industry Standards and Guidelines.
7. Any required capabilities of the subcontractor, especially qualifications and certifications.
8. Applicable test instruments.
9. Scheduling.
10. Hands-On training opportunities.
11. Baselines for preventative maintenance.

C. With regard to the commissioning effort, the project commissioning team will be discussed as the sum of the following parts:

1. The Owner.
2. The Project Commissioning Agent who is responsible to develop and implement the Commissioning Plan.

3. The Contractor's Commissioning Coordinator who is fundamentally responsible for scheduling testing activities, including the tracking and implementation of RFIs, Contract Modifications, and other similar documents that pertain to modification of the commissioned systems.

4. The Test Engineer(s) depending on the system to be commissioned, may be a member of the Architect/Engineer team, a key subcontractor technician, or a subcontractor with specific testing skills. The essential requirement is that a single member of the Contractor's team is designated as the expert for each system or for a few related systems. The Test Engineer has the following responsibilities:

    a. Ensure that the Project Commissioning Agent is provided with appropriate technical documents, and collaborate with the commissioning agent in the creation of the actual detailed test procedures.

        1) Ensure that the Project Commissioning Agent gets a copy of all of the RFIs, Contract Modifications, and other similar internal documents that pertain to modifications of commissioned systems.

    b. Coordinate with the Commissioning Coordinator and the installation crews to ensure that commissioning activities are included as a routine part of everyday work.

        1) Conduct the actual tests or, depending on exactly what is being tested, provide printed documents for the convenience of the testing crew, ensure that the tests are executed properly, and collect the test data from the various testing crews.

        2) Keep the Project Commissioning Agent informed regarding on-going tests that may be observed at the discretion of the commissioning agent.

        3) Keep the Owner informed regarding on-going tests that are appropriate for hands-on training.

    c. Determine when a system, as indicated by the results of the pre-functional and preliminary functional performance tests, is completely installed, proven fully functional and ready for functional performance testing.

    d. Conduct a formally scheduled Functional Performance Test that demonstrates the potential availability of the system for beneficial usage.

    e. Every reasonable effort will be made to incorporate customary subcontractor testing and field quality control procedures as a part of written testing procedures.

5. CALCTP certified field technician

1.06 SCHEDULE

A. For each commissioned system the following items shall be reflected in the project schedule, with additional detail as needed.

Commissioning Task/Activity	Estimated Start Date	Estimated End Date
Include the system on the commissioning meeting agenda		
Distribute approved Pre-Functional Test templates		
Distribute approved Functional Performance Test templates		

Commissioning Task/Activity	Estimated Start Date	Estimated End Date
Construction site visits/inspections		
Conduct Pre-Functional Tests		
Formally scheduled Shop Test demonstration (if required)		
Conduct Functional Performance Tests Onsite		
Conduct Lighting Controls Acceptance Test by CALCTP Technician		
Conduct Training		
Letter of Completion		
Formally scheduled FPT demonstration		
Distribute approved commissioning report for the system		

B. Criteria

1. The Project Commissioning Agent is fundamentally interested in testable parameters.
    a. A scoping specification establishes performance parameters.
    b. A design specification establishes a means of achieving those performance parameters.
    c. The literature provided by the selected manufacturer establishes the specific methods by which the performance parameters can be verified.
2. The Project Commissioning Agent, in collaboration with the Contractor has the responsibility of writing a testing procedure that will verify the performance criteria. Inconsistencies between the criteria specifications, the design specifications, and the indicated capabilities of the equipment become quickly apparent and appropriate remedies can be applied.

C. Milestones: At a minimum, the following milestones, on a per-system basis, shall be included in the Contractor's work plan and formal project schedule.

1. Submittal of preliminary systems design documents for review by the CxA.
2. Submittal of final systems design documents for review by the CxA.
3. Submittal of systems material and equipment data, and shop drawings for review by the CxA.
4. Submittal of systems-related configuration, programming and adjustment data required by the CxA to prepare functional test procedures.
5. Submittal of the results of start-up and pre-functional testing to the CxA.
6. Submittal of the results of functional performance testing.
7. Submittal of information describing the nature, cause and needed corrective action regarding any observed system functionality or performance deficiencies observed during pre-functional and/or functional performance testing.

1.07 CONDUCT OF COMMISSIONING

A. Weekly Commissioning Progress

1. Weekly test reports shall be submitted to provide an effective means of verifying progress.

    a. Pre-functional tests shall reflect the receipt of equipment, its site installation, and its proper operation to the extent that it can be tested as an isolated device.

    b. Shop tests are pre-functional tests that shall reflect the receipt of equipment, its assembly (typically in a free-standing cabinet), and its proper operation in all routine operational modes, to the extent that they can be demonstrated with simulated field inputs and outputs in a subcontractor's off-site shop facility.

    c. Preliminary functional performance tests shall reflect the delivery to the site of any additional assemblies, the installation of all system elements, and the compliant behavior of the system in all operational modes.

    d. A formally scheduled Functional Performance Test demonstration confirms that the system is completely installed and proven fully functional, and is potentially available for beneficial usage.

    e. The approval of a commissioning report that is submitted by the Project Commissioning Agent shall be regarded as a significant milestone in the successful completion of the related system.

2. Field Observations will be used by the Owner in order to identify progress of on-going installations and their required completion sequence, to verify readiness for upcoming testing, and to identify issues of installation so corrections can be made prior to scheduled Commissioning tasks and in order to maintain schedule

3. Weekly Progress shall be used by the Owner and the Contractor to track schedule, milestones, construction sequencing, satisfaction of criteria requirements, conformance to approved material submittals and shop drawings.

B. Diagnosis of the fundamental cause of deficiencies

1. Confirmation of the specified performance during Pre-Functional Tests and Functional Performance Tests, and the discovery and correction of deficiencies, is the fundamental purpose of these tests.

2. The Project Commissioning Agent has no authority to modify the requirements of the contract and can neither direct changes to the specified design nor approve contract modifications.

    a. The Project Commissioning Agent may add steps to a test in order to clarify compliance, or to determine the nature of a suspected problem. Similarly, the Project Commissioning Agent may delete testing steps that are adequately addressed by, for example, a documented system self-test diagnostic.

3. Perform, at no additional cost to the Owner, diagnostic tests and activities as required to determine the fundamental cause of deficiencies observed.

    a. Identify each step of the diagnostic procedure prior to performing the procedure.

    b. Record each step of the diagnostic procedure.

c. Record the conclusion of the diagnostic procedure with regard to the fundamental cause of the deficiency.

4. Determine and record corrective measures.

C. Retesting

1. Corrections during a formally scheduled Functional Performance Test demonstration are generally prohibited to avoid consuming the time of personnel waiting for the test, but not involved in making the correction.

a. Exceptions will be allowed if the cause of the deficiency is obvious and the corrective action can be completed in and agreed upon timeframe. If corrections are made under this exception, the deficient conditions shall be noted on the test report.

2. If a formally scheduled Functional Performance Test demonstration is failing for technical reasons, the Project Commissioning Agent has the authority to abort the test.

a. The Project Commissioning Agent has the authority to resort to testing representative portions of the remaining elements before aborting the demonstration.

b. The Contractor shall repeat, at no additional cost to the Owner, the complete test procedure for each aborted Functional Performance Test demonstration.

1) Repeat the demonstration until acceptable results are achieved.

3. For each repeated demonstration, regardless of the fundamental cause, transmit a new test report, clearly marked as a “Retest”.

D. When deficiencies occur during a formally scheduled Functional Performance Test demonstration, repeated demonstrations may be required to achieve acceptable results. When the deficiencies are determined to result from conditions within the Contractor’s responsibility, the Contractor shall compensate the Owner for direct costs that are incurred.

1.08 COMMISSIONING

A. The Project Commissioning Agent will prepare and maintain a Commissioning Plan document which documents the project commissioning requirements, commissioning-related processes, commissioning schedule, test procedures, project-related reference information and other information pertinent to the planning and execution of the commissioning process. This document is dynamic in nature and shall be periodically updated by the Project Commissioning Agent as needed to maintain a current information record. It is intended that this document will be accessible on-line to all parties involved in commissioning the project.

1.09 SUBMITTALS AND TRANSMITTALS

A. The Contractor shall provide the Project Commissioning Agent with a copy of all submittals, RFIs, and Contract Modifications that pertain to systems that are being commissioned.

B. The Contractor shall provide any requested additional technical information documents to the commissioning agent, in accordance with normal submittal requirements, and collaborate in the development of the test procedures. Carefully review the documents prepared by the Project Commissioning Agent, before they are submitted for approval, to ensure that the planned functional performance test templates are feasible, necessary, and sufficient to demonstrate the specified functionality.

C. The Project Commissioning Agent will provide an electronic copy of each approved test plan template, with representative items filled in, for the inclusion of all remaining items in each subsystem, organized as best suits the convenience of the Test Engineer.

1. Before any testing begins for a particular system, the Test Engineer shall populate the template with the identity and location of each relevant device, and provide the Project Commissioning Agent with an electronic copy for review and comment. Identification of the pertinent RFIs and Contract Modifications is of particular importance.

2. The Test Engineer shall provide the Project Commissioning Agent with an electronic and a printed copy of the current computerized report for all tests that occurred during the previous week, and shall also transmit the original copy of all printed test documents that were hand-annotated by the testing crews.

D. When a system is completely installed, pre-functional testing has been completed and passed, and functional performance tests have been completed and passed with any required corrections made to the system, and all final testing submittals forwarded to the Owner and accepted, the Contractor shall submit a Letter of Completion for that system.

E. Upon successful completion of the formally scheduled Function Performance Test demonstration for each system, the Test Engineer shall forward a computerized version of the test results. The Project Commissioning Agent will then submit a Commissioning Test Report for that system, thereby indicating that the system is potentially available for beneficial usage.

1. The Commissioning Test Report will include:

a. A description of the system

b. The Pre-functional Test procedures

c. The Functional Performance Test procedures

d. Pertinent RFIs, Contract Modifications, and similar documents

e. A log of deficiencies and corrective actions

f. The computerized version of the final test results

g. Course outlines and training attendance rosters, including hand-on training

h. A scanned copy of the weekly documents that were generated during the various tests.

2. The Commissioning Test Report for each system shall be included as a part of the Maintenance Manual submittal for that system.

F. The Owner’s Project Manager shall:

1. Review Requests for Interpretation and provide responses

2. Review submitted documents and provide review comments and approvals

3. Transmit deficiency notices

4. Review Contract Modification Requests and provide the subsequent authorizations

G. The Project Commissioning Agent shall:

1. Collaborate with the Test Engineer and CALCTP technician in the creation of test procedures, and submit the test procedure templates for approval, system by system.

2. Review submitted documents and provide review comments regarding items that effect the testing effort.
3. Transmit deficiency notices
4. Submit commissioning test reports, as systems become potentially available for beneficial usage.
5. Transmit reimbursable direct costs that are incurred, especially for lost time, when formally scheduled Functional Performance Tests are aborted.

H. The Contractor shall:

1. Submit a project schedule that includes testing activities, and transmit frequent updates.
2. Review any comments provided by the Owner's Project Manager on submitted documents, and incorporate the comments into the subsequent documents.
3. Provide additional narrative as may be needed to establish a testable design.
4. Internally transmit deficiency notices.
5. Submit documents that are needed for the creation of test procedures.
6. Populate test procedure templates and transmit them for review.
7. Submit course outlines and training material for review, conduct training, and provide attendance rosters for inclusion in the commissioning report.
8. Transmit interim reports from all commissioning tests that occurred during the previous week.
9. Submit a Letter of Completion, signed by the Test Engineer and other appropriate parties, when a system is completely installed, proven fully functional, and ready for its final tests.
10. Transmit responses to deficiency notices.
11. Transmit Contract Modification Requests and implement the subsequent authorizations.
12. Submit a test report as each system passes its final tests.
13. Transmit reimbursable direct costs that are incurred, especially for lost time, when formally scheduled Functional Performance Tests are aborted.

1.10 QUALITY ASSURANCE

A. Commissioning Coordinator: Submit the resume and qualifications of the Commissioning Coordinator for approval. The Owner reserves the right to personally interview the Commissioning Coordinator prior to accepting placement for the position. Final approval will be by the Owner. The submittal shall demonstrate compliance with the following qualifications.

1. Extensive experience in scheduling the completion of complex power systems that include high voltage electrical, low voltage systems, generation, and automated controls sufficient to understand the amount of time that must be allocated for the testing of such systems.
2. Excellent working knowledge of the relevant systems.
3. Demonstrated ability to coordinate and schedule tests in an environment with multiple subcontractors, and to integrate tests with other construction activities.

4. Demonstrated management skills for keeping Commissioning work on schedule and inducing cooperation from people who may have other priorities.

B. Discipline Test Engineers: Submit the resume and qualifications of each Discipline Test Engineer for approval. Note that several Discipline Test Engineers will be needed although a single Discipline Test Engineer may be designated for a few small, closely related systems. The Project Commissioning Agent and the Owner's Project Manager reserve the right to personally interview any proposed Discipline Test Engineer prior to accepting placement for the position. Final approval will be by the Owner's Project Manager. The qualification submittal shall demonstrate compliance with the following qualifications.

1. Extensive experience in the start-up and troubleshooting of complex electrical systems similar to the relevant systems.

2. Excellent working knowledge of the relevant systems; be capable of understanding the control vendor's operating system and programming; and be capable of troubleshooting programs and recommending necessary modifications.

3. Demonstrated ability to coordinate and schedule testing work in an environment with multiple subcontractors, and integrate with other construction activities.

4. Demonstrated abilities with technology transfer as it relates to the training of Owner operational personnel and maintenance personnel.

C. Test instruments shall have a current calibration that is provided by a NIST traceable testing laboratory.

1.11 FUNCTIONAL PERFORMANCE TESTS

A. Functional Performance Tests shall address the dynamic behavior of systems (rather than just components) under full operation.

1. Systems shall be tested under various modes of operation and source connection to replicate the dynamic changes that are expected on a regular basis. Both automatic, SCADA, and manual modes of operation shall be simulated and verified.

2. The systems shall be run through all of the control system's sequences of operation and components are verified as responding per the specifications.

3. Lighting system controls shall be tested and certified by a CALCTP technician.

4. Mechanical system controls and sequences shall be commissioned in accordance with Section 23 0800.

B. The Project Commissioning Agent will provide testing procedures and a reporting template for each type of device for each system.

1. The Project Commissioning Agent develops the functional test procedures and reporting templates in a sequential written form and observes many of the preliminary tests.

2. The Test Engineer is responsible for filling in the actual device names and locations in the template, and for organizing the tests in the most efficient manner.

3. The test reporting lists from the related Pre-Functional Testing can often be dropped directly into the templates for Functional Performance Tests.

C. During the formally scheduled Functional Performance Test demonstration, the Project Commissioning Agent shall determine the verification level that will be needed to determine that previously accomplished test results are still valid, and that the entire system is performing as specified.

D. For each commissioned system, the final commissioning step shall be a formally scheduled Functional Performance Test demonstration that confirms the system is completely installed, proven fully functional, and in compliance with the specification.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with Owner's Standard Operating Procedures and this section for Commissioning of Electrical Systems for procedures, responsibility, checklist and test forms as required when preparing the commissioning plan and documentation.

3.02 EXAMINATION

A. Verify that equipment testing work is complete before starting functional performance of power equipment.

B. Verify that operational manuals are complete and been approved by the Engineer before starting functional performance testing.

C. Inspect equipment and confirm that it has passed all acceptance tests, is clean and ready for operation. Confirm all shipping tags are removed, nameplates installed and equipment manuals in place.

3.03 PREPARATION

A. Provide for manufacturer's factory representative and SCADA control programmer to be on site for this work.

B. Provide the written functional performance test procedures to all parties for review and comment.

C. Provide certified testing agency personnel for this work as required in this section.

D. Schedule all personnel required to witness the tests.

E. Transfer all campus loads to an alternate source of supply or provide temporary generators if required to maintain loads energized during testing. All campus loads are to remain energized during the commissioning process.

3.04 SYSTEMS COMMISSIONING

A. Provide all personnel and equipment necessary to perform commissioning work after equipment is installed, all acceptance tests are complete, and systems are ready for operation.

B. Perform commissioning work in accordance with the Commissioning Plan and equipment manufacturer's standard procedures and check lists, including but not limited to:

1. Verify proper operation for equipment, cable, and installations such as:
    a. Main Switchgear Transfer between Sources, Tie Breaker
    b. Programmed Interlocks between Main and Tie Breaker
    c. SCADA system controls
    d. Microgrid Controls
    e. 15kV Cable.

f. Ground resistance.

g. Instrument Transformers.

h. Protective Relays.

i. 12kV-208Y/120V Transformers.

j. 208/120V Power Systems.

k. Power Metering.

l. HMI Devices and Controls.

m. Lighting Controls.

n. Mechanical System Controls.

o. Verify that all power system equipment is performing as outlined in the basis of design and the Commissioning Plan, as well as sequence of operation scenarios.

3.05 RESULTS

A. If specified equipment performance is not satisfactory and verified, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

3.06 TRAINING

A. Training shall be provided to ensure that operations and maintenance personnel understand how to care for the equipment.

B. Operational training shall focus on the routine operation of the equipment, including the appropriate response to anticipated alarm conditions.

C. Maintenance training shall focus on troubleshooting and the repair of equipment, with a particular emphasis on the use of baseline documentation that was generated during the commissioning process and the replication of those tests.

D. Include in the training materials and demonstrations observed system conditions at defined test points, and methods for isolating various portions of the system in order to verify that they are performing correctly.

E. Maintenance training course content shall be appropriate for technically trained personnel who are familiar with similar types of systems. The training emphasis shall be on the unique characteristics of the equipment as they apply to this specific project.

F. Project specific diagrams and other visual aids, with related functional narratives, shall be incorporated in training materials

G. The representation of the system in the project specifications and drawings shall be incorporated.

H. A tour of the facility shall be included as part of the training, to ensure familiarity with the system devices and their physical location.

I. Include opportunities for hands-on operation of the system, including the various germane testing and maintenance activities.

J. Document and provide attendance records for each training session. A minimum of three four (4) hour training sessions, each conducted on separate days are required to be included in the project bid cost.

3.07 FINAL COMMISSIONING REPORT

A. A final Commissioning Report by the Project Commissioning Agent will be provided in printed and electronic format to the Owner. The report will include:

1. An executive summary
2. An overview of commissioning and testing scope
3. A list of participants and their roles
4. Brief system descriptions
5. A general description of the testing and verification methods.
6. A statement that the Commissioning Test Report for each of the systems has been submitted and approved, and that all of the commissioned systems are available for beneficial usage.
7. All test reports prepared during pre-functional testing and start-up
8. A copy of all manufacturers' equipment operation and maintenance manuals.
9. Copies of project correspondence related to commissioning including RFI's, deficiency notices, punchlists, and design directives
10. Training materials, curriculum, and sessions submitted in print and on DVD.
11. Copy of sequence of operations and systems operating procedures and instructions
12. Summary of all key personnel contact information and responsibility who were involved in the pre-functional testing and system performance testing.

END OF SECTION

SECTION 26 2416 – PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0548 – Vibration and Seismic Controls for Electrical Systems.

D. Section 26 0553 – Identification for Electrical System.

E. Section 26 0573 – Electrical Power System Study.

F. Section 26 0800 – Electrical Testing Requirements

1.03 REFERENCE STANDARDS

A. FS W-C-375 – Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2013 (ANSI/NEMA PB 1.1).

G. CEC – California Electric Code; Most Recent Addition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

J. UL 67 - Panelboards; Current Edition, Including All Revisions.

K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

L. UL 869A – Reference Standard for Service Equipment; Current Edition, Including All Revisions.

M. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.

1.04 SUBMITTALS

A. Comply with 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories, include outline and dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements. Provide a PDF file with all panelboard schedules and branch circuit identification.

E. Maintenance Data: Include information on replacement parts; and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE

A. Conform to requirements of CEC.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

C. Product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer’s instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacture’s written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General Electric

B. Schneider Electric; Square D Products

C. Eaton Corporation

2.02 ALL PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).

2. Ambient Temperature:

   a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

C. Short Circuit Current Rating:

1. Short circuit interrupting rating and bracing shall exceed the final calculated available fault current at the installed location as indicated on the Owner's approved coordination study or the Contractor required provided power system study, as applicable to the project scope of work.

2. Series rated breakers are not acceptable unless agreed to in writing with the Engineer of Record and Owner's Representative.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service entrance equipment according to UL 869A.

E. Mains: Configure for top or bottom termination of incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable terminal lug for connecting all installed and future feeder or branch circuit requiring a neutral connection.

2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable terminal lug for all installed and future feeder and branch circuit equipment grounding conductors.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

   a. Indoor Clean, Dry Locations: Type 1

   b. Outdoor Locations: Type 3R

2. Boxes: Galvanized steel unless otherwise indicated.

   a. Provide wiring gutters sized to accommodate the conductors to be installed.

3. Fronts

   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.

2. Main and Neutral Lug Type: Mechanical.

C. Bussing

1. Phase and Neutral Bus Material: Copper.

2. Ground Bus Material: Copper.

D. Circuit Breakers

1. Provide bolt-on type.

2. Breakers with pad locking provisions.

3. Molded case breakers for amp frames of 150 or less.

4. Electronic Trip Circuit Breakers molded case with electronic sensing, timing and tripping circuits for adjustable current settings; UL listed. All frames from 225A to 1200A shall use field installed rating plugs (70A to 1200A) to establish or change the ampere rating and shall be suitable for reverse feed. Digital microprocessor trip system shall be applicable for 60Hz systems and shall accurately sense sinusoidal and non-sinusoidal current waveforms (fundamental through the thirteenth harmonic order on a 60Hz base) by continuously sampling each phase throughout life cycle. Breakers shall function normally at up to 95% relative humidity, non-condensing

5. Electronic Trip Circuit Breakers molded case style breakers with solid state, microprocessor-based, true rms sensing as identified on single-line diagrams as LSI or LSIG or larger than 1200A frame. Breakers as molded case style with electronic sensing, timing and tripping circuits for adjustable current settings; UL listed. All frames from 100A to 4000A shall use field installed rating plugs (15A to 4000A) to establish or change the ampere rating and shall be suitable for reverse feed. Digital microprocessor trip system shall be applicable for 60Hz systems and shall accurately sense sinusoidal and non-sinusoidal current waveforms (fundamental through the thirteenth harmonic order on a 60Hz base) by continuously sampling each phase throughout life cycle. Breakers shall function normally at up to 95% relative humidity, non-condensing

a. Provide the following field-adjustable trip response settings:

1) Instantaneous trip.

2) Adjustable short time trip.

3) Short time delay setting of I^2T in and out.

4) Long time trip.

5) Long time delay setting.

6) LSIG trip unit shall include ground fault pickup

7) LSIG trip unit shall have time delay setting of I^2T in and out

8) Breakers shall be 100% rated as indicated on the single lines diagrams

9) Provide neutral sensor for ground fault trip if load has neutral conductor.

E. Enclosures

1. Provide surface-mounted enclosures unless otherwise indicated.

2. Provide an overall door when indicated.

3. Provide flush mounted where indicated with door style dead front with key lock

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.

2. Main and Neutral Lug Type: Mechanical.

C. Bussing

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.

2. Phase and Neutral Bus Material: Copper.

3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

1. Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Lug Material: Copper, suitable for terminating copper conductors only.

3. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

4. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

5. Provide Ground Fault circuit breakers where indicated.

6. Provide Arc Fault circuit breakers where indicated.

E. Enclosures

1. Provide surface-mounted or flush-mounted enclosures as indicated.

2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separated lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.

3. Provide clear plastic circuit directory holder mounted on inside of door.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and CEC.

D. Provide required supports in accordance with Section 26 0529 Hangers and Supports for Electrical Systems and seismic restraints and mounting per Section 26 0548 Vibration and Seismic Controls for Electrical Systems.

E. Install panelboards plumb.

F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

H. Provide minimum of four spare conduits of which three are ¾ and one is 1 ½ inch trade size out of each flush-mounted panelboard with pull strings shall be terminated into the accessible space above ceiling.

I. Provide grounding and bonding in accordance with Section 26 0526 Grounding and Bonding for Electrical Systems.

J. Install all field-installed branch devices, components, and accessories.

K. Provide filler plates to cover unused spaces in panelboards.

L. Provide circuit breaker locking devices to prevent unauthorized personnel from de-energizing life safety and essential loads where indicated. All fire detection and alarm circuits shall be red and lockable.

M. Install all equipment and circuit identification in accordance with Section 26 0553 Identification for Electrical System.

N. Install a typed panel schedule in all panelboards. The panel schedule shall be based on final installed conditions, including circuit changes made during construction. A PDF for each panel schedule shall be included in the close-out documentation.

3.02 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard covers and doors.

3.03 FIELD QUALITY CONTROL

A. Test in accordance with Section 26 0800 Testing Requirements.

B. Correct deficiencies and replace damaged or defective panelboards or associated components.

C. Adjust breakers with adjustable settings in accordance with Section 26 0800 Testing Requirements and the Owner’s approved coordination study or the Contractor required provided power system study, as applicable to the project scope of work.

3.04 CLEANING FIELD QUALITY CONTROL

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

C. Provide all missing hardware required to secure panel covers.

END OF SECTION

SECTION 26 2713 – ELECTRICAL POWER METERING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Equipment for Owner electricity metering:

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0553 – Identification for Electrical Systems.

C. Section 26 0800 - Electrical Testing Requirements.

D. Section 26 0801 - Commissioning of Electrical Systems.

E. Section 26 1319 – Medium Voltage Metal-Clad Switchgear.

1.03 REFERENCE STANDARDS

A. ANSI C12.1 – Electric Meter Code for Electricity Metering.

B. ANSI C12.20 – American National Standard for Electricity Meters – 0.2 and 0.5 Accuracy Classes.

C. IEC 62053-21 – Electricity Metering Equipment (A.C.) – Particular Requirements – Part 21: Static Meters for Active Energy (Classes 1 and 2); International Electrotechnical Commission.

D. IEC 62053-22 – Electricity Metering Equipment (A.C.) – Particular Requirements – Part 22: Static Meters for Active Energy (Classes 0,2 S and 0,5 S); International Electrotechnical Commission.

E. IEC 62053-23 – Electricity Metering Equipment (A.C.) – Particular Requirements – Part 23: Static Meters for Reactive Energy (Classes 2 and 3); International Electrotechnical Commission.

F. IEEE 1459 – Standard Definitions for the measurement of Electrical Power Quantities Under Sinusoidal, Nonsinusoidal, Balance, or Unbalanced Conditions; Institute of Electrical and Electronic Engineers.

G. IEEE C57.13 – IEEE Standard Requirements for Instrument Transformers; Institute of Electrical and Electronic Engineers.

H. NECA 1 – Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.

I. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

J. NETA ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electric Testing Association.

K. CEC – California Electrical Code; Most Recent Addition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for electricity metering systems and associated components and accessories. Include ratings, configurations, standard wiring diagrams, dimensions, service condition requirements, and installed features.

C. Shop Drawing: Include system interconnection schematic diagrams showing all factory and field connections. Include requirements for interface with other systems.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field Quality Control Test Reports.

F. Project Record Documents: Record actual installed locations of meters and final equipment settings.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work to provide equipment suitable for interface with electricity metering systems to be provided.

2. Coordinate work with other installers to provide communication lines required for electricity metering system interface.

3. Coordinate with Owner representative and other related equipment manufacturers to discuss metering system interface requirements. Obtain network credentials, such as IP addresses and gateways, from Owner's network representative.

4. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.06 QUALITY ASSURANCE

1. Conform to requirements of CEC.

PART 2 - PRODUCT

2.01 MANUFACTURERS

A. Electro Industries

B. Or approved equal.

2.02 CONFIGURATION

A. As shown on drawings:

1. Type 'PMA' meters – Nexus1500+ -D2-60-20-V1or approved equivalent.

2. Type 'PMB' meters – Shark 250-60-10-V2-D2-INP100S or approved equivalent.

2.03 EQUIPMENT FOR OWNER ELECTRICITY METERING

A. Provide microprocessor-based digital electricity metering systems including all instrument transformers, wiring, and connections necessary for measurements specified.

B. The meter shall be UL listed.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Provide electricity metering systems and associated components compatible with the equipment and associated circuits to be metered.

E. Service Conditions: Provide electricity meters suitable for operation under the service conditions at the installed location.

F. Enclosures:

1. Meters installed directly in power equipment:

   a. In control aux compartments with hinged cover.

   b. Display mounted in aux compartment door.

   c. Top of meter display not to exceed 64 inches from floor of room.

2. For meters not installed directly mounted in power equipment:

   a. Where not furnished by manufacturer, provide required cabinets and enclosures in accordance with Section 26 0537 Boxes. Size boxes according to equipment and terminals to be included, with required space for wire bending in accordance with the CEC.

   b. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

      1) Indoor Clean, Dry Locations: Type 1.

      2) Outdoor Locations: Type 4.

   c. Finish: Manufacturer's standard unless otherwise indicated.

   d. Display mounted on cabinet hinged door.

   e. Top of meter display not to exceed 64 inches from floor of room or final grade.

G. Provide meters in suitable location for operation under the service conditions and accessible for servicing.

H. Control voltage shall be 120 volts AC for power meters. Provide step down transformer with class CC fuses on primary and secondary.

I. Voltage sending to power meters shall be via a fuse. For 3 phase voltages use 3 single phase class CC fuses.

J. Finger safe voltage fuse blocks with flip open cover to disconnect each fuse and replace. Location of fuse blocks in accessible compartments and not in the main bus sections of switchboards or switchgear. Fuse blocks for class CC fuses.

K. Shorting blocks shall be provided for all current transformers.

L. Shorting blocks for all current transformers and located in accessible compartments and not in the main bus sections of secondary unit substations, switchboards or switchgear.

M. PMA Meters (Refer to Drawings for Meter Designation and Locations):

1. The power quality meter shall be designed for multifunction electrical measurement on 3 phase power systems.
    a. The power quality meter shall support 3 element Wye, 2.5 element Wye, 2 element Delta, and 4 wire Delta systems.
    b. The power quality meter's surge withstand shall conform to IEEE C37.90.1 and ANSI C62.41 (6 kV).
    c. The power quality meter shall be user programmable for voltage range to any CT or PT ratio.
    d. The power quality meter shall have a voltage burden of not more than 0.072 VA per phase Max at 600 volts, and 0.003 VA per phase Max at 120 volts.
    e. The power quality meter shall have a current inputs burden of not more than 0.008 VA per phase max at 20 A.
    f. The power quality meter shall accept a voltage input range of (5 to 347)VAC Line to Neutral, and a range of (10 to 600)VAC Line to Line.
    g. The power quality meter shall accept a current reading of up to 20 A continuous. Start-up current for a 5 A input shall be no greater than 0.005 A.
    h. The power quality meter shall have a frequency range of (42.5 to 69.9)Hz.
2. The power quality meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter, ensuring the meter cannot be a point of failure on the CT circuit. The second method shall provide additional termination pass-through bars that allow the CT leads to be terminated on the meter.
    a. The Fault Current Withstand shall be 100 A for 10 seconds, 300 A for 3 seconds, and 500 A for 1 second at 23° C.
    b. The Pass-through wire gauge dimension of 0.177" / 4.5 mm shall be available.
    c. All inputs to outputs shall be isolated to 2500 VAC.
3. The power quality meter shall measure and report the following quantities at a minimum:
    a. Watts (total and per phase), VARs (total and per phase), VA (total and per phase), power factor (total and per phase), voltage max/min in the interval, and frequency. The meter shall support high-speed readings updated every cycle, and also programmable high-speed readings updated every 2-20 cycles, simultaneously. Readings shall be available for both metering and control. All specified readings shall be made available through the meter's standard and optional communication ports. An additional set of highest accuracy, one second readings, shall also be available.
    b. Accumulated watt-hour, VA-hour, and VAR-hour; watt-hour received; watt-hour delivered; VAR-hour and VA-hour readings shall be accumulated and stored for each of the 4 quadrants of power.
    c. Power demand shall be simultaneously calculated using four different averaging methods: Fixed Window (Block) Average, Sliding Window (Rolling Block) Average, Thermal Average, and Cumulative Demand. Values for all averaging intervals must be available simultaneously.

d. Fixed Window (Block) Average interval shall be user-settable from one second to 18 hours. Sliding Window (Rolling Block) Average sub-interval shall be user-settable from one second to 18 hours. The number of intervals in the Sliding Window (Rolling Block) Average shall be user-settable from one to 255 sub-intervals.

4. The power quality meter shall compensate for errors in current transformers and potential transformers.

   a. Errors shall include voltage, multipoint current, multiphase angle, and better than .01% resolution.

   b. The unit shall utilize five different current compensation points per phase, wherein the points shall be concentrated at the lower end of the dynamic range.

5. The power quality meter shall provide the following accuracies. Accuracies shall be measured as percent of reading at standard meter test points.

   a. Power meter shall meet ANSI C12.20 for Class 0.2 and IEC 62053-22 Class 0.2S accuracy requirements.

   b. Voltage accuracy shall be within less than 0.05% for the one second reading and less than 0.1% for 100 millisecond reading.

   c. Current accuracy shall be within less than 0.025% for the one second reading and less than 0.1% for the 100 millisecond reading.

   d. Frequency shall have a display resolution accuracy of less than 0.01 Hz for the one second reading and less than 0.03 Hz for the programmable 2-20 cycle readings.

   e. The meter shall have an internal precision real time clock providing max accuracy at full temperature range to 3.5 ppm, or less than 10 seconds per month drift.

   f. The meter shall offer a Test mode that allows accuracy testing via the meter's front KYZ pulses. Test mode shall offer options (positive or negative watt-hour or positive or negative VAR-hour, per quadrants; test with or without Transformer/Line Loss Compensation and PT/CT Compensation) through software and support preset accumulators upon exiting Test mode.

6. The power quality meter shall have calibration components that include:

   a. Precision internal references with real-time auto calibration for voltage and current channels.

   b. The ability to self-calibrate at a rate not longer than every ten seconds, for the life of the meter.

   c. The meter must stabilize its readings once "out of the box" and connected, within 10 seconds.

7. The power quality meter shall include upgrade packs that shall enable in-field upgrade without removing the installed meter.

   a. The three upgrade packs shall be:

      1) V1 - Standard power quality meter as described in this document with 512 MegaBytes memory and 512 samples per cycle.

      2) V2- V1 plus 1 GigaByte memory and 1024 samples per cycle.

3) V3 - V2 plus 4 GigaBytes memory and 50 MHz Transient recording.

4) V2 and V3 shall enable an IEC 61850 Protocol Network Server for either the standard or optional Ethernet port.

8. The power quality meter shall include an integrated 5.7-inch touch screen TFT LCD color display with multiple display modes.

   a. Display shall support 4 groups of screens: Real Time, Trending, Alarms, and Power Quality modes. Groups of screens shall include:

      1) Real Time viewing of voltage, current, power, demand.

      2) Accumulated Energy and Time of Use readings.

      3) Flicker readings in Instantaneous, Short Term (PST), and Long Term (PLT).

      4) Alarm conditions.

      5) Phasor analysis.

      6) Harmonic spectrum analysis and waveform scopes for both voltage and current.

      7) Real Time trending.

      8) Log status.

      9) Configuration settings.

      10) Time of Use.

      11) Test Mode.

   b. The Display shall be constructed of bright TFT glass with a high temperature and long-life LED backlight. CCFL backlight shall not be acceptable.

   c. The meter shall have two LED accuracy test pulses on the meter front.

   d. The display shall support screen rotation to enable vertical meter mounting.

   e. The display shall be selectable for 6 embedded languages - English, Spanish, French, Chinese, Polish, and Portuguese – and shall supply two additional optional language input packs.

9. The power quality meter shall provide multiple digital communication ports and support multiple open protocols:

   a. The meter shall include an ANSI Optical port that supports speeds of up to 57,600 bps, for communication to external devices.

   b. The meter shall have one standard 10/100BaseT Ethernet port. With V2 and V3 upgrade packs, this Ethernet port shall offer IEC 61850 protocol in addition to Modbus TCP/IP and DNP 3.0. The IEC 61850 protocol Ethernet network server shall provide the following features:

      1) Integrates into any IEC 61850 network.

      2) Provides support for Modbus TCP/IP, DNP 3.0, and IEC 61850 protocols simultaneously.

      3) Configurable for multiple logical nodes.

4) Provides buffered and unbuffered reporting.

5) Provides configurable .ICD and .CID files.

6) Provides GOOSE messaging.

7) Provides alarms and waveform capture in response to GOOSE messages.

c. The meter shall have a second Ethernet port. Optional Ethernet port shall be available as either 10/100BaseT or 10/100Base-FX Fiber Optic configuration. With V2 and V3 upgrade packs, the 10/100BaseT Ethernet port shall provide optional IEC 61850 protocol in addition to Modbus TCP/IP. The IEC 61850 protocol Ethernet network server shall provide the following features:

1) Integrates into any IEC 61850 network.

2) Provides support for Modbus TCP/IP, DNP 3.0, and IEC 61850 protocols simultaneously.

3) Configurable for multiple logical nodes.

4) Provides buffered and unbuffered reporting.

5) Provides configurable .ICD and .CID files.

6) Provides GOOSE messaging.

7) Provides alarms and waveform capture in response to GOOSE messages.

d. The standard and optional Ethernet ports shall be separately configurable to enable or disable each port's protocol and service, independently, for the following functions:

1) DNP LAN/WAN over Ethernet.

2) Modbus TCP/IP server.

3) Modbus TCP/IP client.

4) HTTP Web access.

5) SMTP email client for alarm notification.

6) SNTP time synchronization.

7) FTP server support.

8) IEC 61850 protocol server (only one port at a time can be enabled for IEC 61850).

9) Separate port numbers can be assigned for every network service.

e. The meter shall have two optional RS485 ports through the Dual Pulse Output/RS485 card. The card shall have 4 user-programmable KYZ pulse outputs. Each RS485 port shall be user configurable with regard to speed, protocol, address, and other communications parameters. All ports shall support a communication speed of up to 115200 baud simultaneously, and be assignable for Modbus or DNP 3.0 communication.

f. The meter shall have a high-speed USB port mounted on the front panel.

g. The meter shall communicate simultaneously using Modbus RTU, Modbus ASCII, DNP 3.0, Modbus TCP/IP, DNP over Ethernet, and, with V2 and V3 upgrade packs, IEC 61850 protocols as standard configurations. All instantaneous data, logged data, event data, power quality analysis and waveform information shall be available using both Modbus TCP/IP and FTP file transfer format. The meter shall also provide means for custom Modbus mapping.

h. The meter shall include DNP 3.0 protocol utilizing a level 2 implementation, for communication to SCADA systems. All instantaneous data and average data shall be available using DNP 3.0 protocol.

10. The meter shall have input/output expandability through four Option card slots on the meter's back and through optional external input/output modules.

a. The Option cards shall be capable of being installed in the field, without removing the meter from installation.

b. The meter shall auto-detect the presence of any Option cards.

c. The available Option cards shall be:

1) Dual RS485/Pulse Output card.

2) Ethernet card with RJ45 or Fiber Optic port with 100BaseT support.

3) Up to two Relay Output cards with 6 output relays on each card.

4) Up to two Digital Input Status cards with 16 inputs on each card.

5) The meter shall have optional external input/output modules in the following configurations:

a) The meter shall support up to 4 Analog Output Modules in 0-1 mA or 4-20 mA, in either 4 or 8 analog output models.

b) The meter shall support up to one Digital Dry Contact Relay Output Module, with 4 relay outputs.

c) The meter shall support up to 4 Digital Solid State Pulse Output modules for KYZ pulsing.

d) The meter shall support up to 4 Analog Input Modules for external sensing of temperature or process conditions.

d. In total the meter must be able to support 13 external I/O modules.

1) External input/output modules shall be powered by external power source and attached to the meter with mounting brackets. Mounting brackets shall come equipped with DIN Rail mounting clips.

11. The power quality meter's Ethernet port(s) shall act as a Web server.

a. Web server shall host webpages with meter information. Multiple meters may be displayed on the webpages. Webpages shall be viewable using any standard Internet browser. Webpages shall provide access to live meter readings, power quality information, and general meter information, and also shall enable remote upgrades to the meter's firmware.

b. Web server shall operate without ActiveX controls or Java Applets and shall be readable via smart phone and/or tablet computing devices.

c. Web server shall operate through firewalls.

d. Web server shall support emailing of alarm conditions to configured email addresses.

e. Web server shall be fully customizable.

f. The meter shall support DNP over Ethernet and at least 32 simultaneous sockets Modbus TCP/IP per each Ethernet card, standard and optional.

12. The power quality meter shall internally record and store Time of Use data.

a. The following Time of Use parameters must be included:

1) Bi-directional consumption and demand.

2) Configurable month and season accumulators.

3) Up to 4 seasons and 12 months available.

4) Perpetual TOU profile that only needs to be set up once and can be used for unlimited number of years.

b. The meter must provide the following TOU information for all rates in real time.

1) Current month accumulations

2) Previous month accumulations

3) Current season (or weekly, or daily) accumulations

4) Previous season (or weekly, or daily) accumulations

5) Total accumulations to date

6) Cumulative demand

c. Full four quadrant accumulations for watt-hr, VAR-hr, VA-hr and coincident VARs during peak watt demand including max demand, shall be available for each rate schedule, each season and for total accumulations.

d. Continuous cumulative demand shall be available.

13. The power quality meter shall have eight built-in digital high-speed status inputs:

a. Inputs shall automatically sense when the circuit is externally wetted.

b. If externally wetted, inputs shall accept up to 150 VDC; if internally wetted the meter shall supply the necessary voltage for the control application.

c. Status inputs shall be configurable for pulse accumulation, pulse synchronization, or event monitoring. When used for pulse accumulation, each input shall have an accumulating register to count incoming pulses.

d. All changes in status shall be time stamped to the nearest millisecond and placed in an event log with time and event label information.

e. Event log shall enable users to recreate sequence of events involving external status points.

f. High-speed status inputs shall be able to trigger waveform recording to the waveform log.

g. Inputs shall record at 1 cycle RMS, and also be programmable for 2-20 cycles RMS recording.

14. The power quality meter shall enable users to perform Flicker analysis and reporting and shall comply fully with the requirements of IEC 61000-4-15 and IEC 61000-4-30 Class A.

    a. The meter shall provide logging and monitoring for Instantaneous, Short Term readings (PST-10min) and Long Term readings (PLT-4 hour).

    b. Flicker shall support both 220 volt/50 Hz systems and 120 volt/60 Hz systems.

    c. The meter shall offer full reporting of power quality conditions using the IEC 61000-4-30 Class A methodology. The meter shall support automatic generation of IEC 50160/IEC 61000-4-30 reports at user-settable intervals. Reports shall be viewable with a Log Viewer program and downloadable to other applications. In support of IEC 61000-4-30 Class A methodology, the meter shall calculate group and sub-group values for harmonics and interharmonics, up to the 51st order. Thresholds for the harmonic and interharmonic values shall be programmable. The sub-group readings and over-threshold status shall be available through the Flicker log and Modbus registers.

    d. The meter shall offer programmable thresholds for all of the IEC 61000-4-30 reporting values so the user can customize their EN 50160 report as needed.

15. The power quality meter shall have 16-bit Waveform and Fault Recorder.

    a. The meter shall record up to 1024 samples per cycle continuously on all 8 channels simultaneously, and transient captures sensitive to at least 800,000 samples per cycle. Storage for recorded waveform samples shall be up to 4000 MegaBytes.

    b. The meter shall perform voltage and current recording with pre and post-event analysis when a waveform limit is exceeded. Pre and post-events shall be configurable to up to 179 cycles.

    c. Fault recording shall offer 8 times full scale capture capability.

    d. The meter shall allow viewing of Harmonic magnitudes to the 511^{th} order. Real time Harmonic magnitudes shall be resolved to the 127^{th} order. The meter's Harmonic measurement shall fully comply with the IEC 61000-4-7 standard.

    e. Percent THD and K-factor shall be calculated by the meter.

    f. The accuracy of the IRIG-B time stamping of the waveform capture shall be 100 microseconds.

16. The power quality meter with upgrade pack V3 shall have a sub-cycle Transient recorder.

    a. The transient recorder shall process 50 MHz high-speed voltage transients.

    b. Transients will be analyzed utilizing a field programmable gate array (FPGA) to designate the high peak transient magnitude and its duration in nanoseconds.

17. The power quality meter shall be equipped with extensive non-volatile memory for recording logs and programming data.

a. The meter shall be equipped with at least 4000 MegaBytes of non-volatile storage.

b. In the event of loss of control power, the data stored in memory shall be retained for no less than ten years.

c. The meter shall have no less than eight historical logs. Each historical log shall be user configurable, and the user can allot the amount of memory for each log. The user must be able to select up to 128 parameters per log.

d. The meter shall have a log for limits/alarms. The Limits log shall provide magnitude and duration of an event, its time-stamp, and log value.

e. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a time-stamp: demand resets, password requests, security information (e.g., sealing switch activation, network password change), system startup, energy resets, log resets, log downloads, Firmware updates Test Mode activity, meter time changes, clock compensation activity, changes to IEC 61850 SCL file, TOU Profile update, change in meter's serial number, updates to meter boards or display, and programmable settings changes.

f. The meter shall have a log for High-speed Input status changes.

g. The meter shall store a separate ITIC/CBEMA log that records magnitude and duration of voltage and current surges and sags for every power quality event. The CBEMA log shall be downloadable through the digital communication ports.

18. The power quality meter shall provide a separate IRIG-B input for time synchronizing to a GPS time signal.

a. IRIG-B input shall accept un-modulated time signal input from a standard GPS satellite clock.

b. Time input shall enable synchronizing of meter time to within one millisecond of Universal Standard Time as transmitted by the GPS clock system. Synchronizing shall not be subject to network or other delays.

19. The power quality meter shall be programmable by software supplied by the meter manufacturer.

a. Software shall have a user-friendly, Windows® OS compatible interface.

b. Software shall include capacity to program meter, download meter, and analyze downloaded data files.

c. Software shall store all data in an ODBC compliant database. Data based storage shall include all log and waveform data.

20. The power quality meter shall provide limits/alarms and control capability as follows:

a. Limits shall be configurable for any measured parameter.

b. Up to 32 limits shall be configurable.

c. Limits shall be based on % of Full Scale settings.

d. Manual Relay control shall be available through software.

e. Relay set delays and reset delays shall be available.

f. The meter shall allow alarms and waveform recording based on IEC 61850 protocol GOOSE messages.

21. The power quality meter shall be able to act as a Master RTU device.

a. The meter shall have the ability to poll remote Modbus slave devices, read data from the slave devices, and log the data for RTU concentrator functions.

b. The meter's Master RTU port shall support Modbus RTU.

22. The power quality meter shall have password and sealing switch protection.

a. The meter shall support a bi-level and extended password configuration.

1) Level 1 shall provide access to TOU accumulations.

2) Level 2 shall provide access to all password protected functions.

3) Level 2 shall allow the creation of up to 8 additional password profiles with specific restrictions and capabilities.

b. The meter shall support a sealing switch consisting of a physical lock located on the bottom left section of the meter front, and a software setting to enable/disable the sealing switch. When it is enabled, the sealing switch shall further restrict access to password protected features, such as demand resetting.

23. The power quality meter shall be appropriately constructed to provide long life in abusive physical and electrical environments.

a. Meter firmware shall be held in flash RAM and shall be upgradeable through one of the communications ports, without removing the unit from service.

b. The meter shall operate successfully at temperature extremes of -20 ^{o}C to +70 ^{o}C.

c. Depending on ordered option, the meter shall operate with control power from either (100-240)VAC or (90-265)VAC@50/60 Hz ; (100-370)VDC; or (18-60)VDC.

d. The meter shall have a standard 4-year warranty, minimum.

N. PMB Meters (Refer to Drawings for Meter Designation and Locations):

1. The meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The meter shall perform to spec in harsh electrical applications in high and low voltage power systems.

a. The meter shall support 3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.

b. The meter shall accept universal voltage input.

c. The meter's surge withstand shall conform to IEEE C37.90.1.

d. The meter shall be user programmable for voltage range to any PT ratio.

e. The meter shall accept a burden up to 0.36VA per phase, Max at 600 V, and 0.014 VA at 120 Volts.

f. The meter shall accept a voltage input range of up to 576 Volts Line to Neutral, and up to 721 Volts Line to Line.

g. The meter shall accept a current reading of up to 11 Amps continuous.

h. The meter shall have color-coordinated voltage and current inputs.

i. The meter shall have a phasor diagram, through software, that clearly shows wiring status.

2. The meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter. The second method shall provide additional termination pass through bars, allowing the CT leads to be terminated on the meter. The meter must support both termination methods.

   a. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.

   b. The meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable.

   c. The meter shall accept a burden of 0.005 VA per phase, Max at 11 Amps.

   d. The meter shall begin reading at 0.1% of the nominal current.

   e. Pass through wire gauge dimension of 0.177” / 4.5 mm shall be available.

   f. All inputs and outputs shall be galvanically isolated to 2500 Volts AC.

   g. The meter shall accept current inputs of class 10: (0 to 10) A, 5 Amp Nominal, and class 2 (0 to 2) A, 1 Amp Nominal Secondary.

3. The meter shall have an accuracy of +/- 0.1% or better for Volts and Amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (Class 0.2%) and ANSI C12.20 (Class 0.2%). ANSI C12.20 shall have a third party certification. The meter shall have a Frequency measurement accuracy of not less than 0.007 Hz.

   a. The meter shall provide true RMS measurements of voltage, - phase to neutral and phase-to-phase; and current, per phase and neutral.

   b. The meter shall calculate RMS readings, sampling at over 400 samples per cycle on all channels measured readings continuously with no cycle blind spots.

   c. The meter shall utilize 24 bit Analog to Digital conversion.

   d. The meter shall provide %THD (% of Total Harmonic Distortion). Harmonic magnitude recording to the 40^{th} order shall be available for voltage and current harmonics.

4. The meter shall provide a simultaneous voltage and current waveform recorder.

   a. The meter shall be capable of recording 512 samples per cycle for a voltage sag or swell, or for a current fault event.

   b. The meter shall provide pre- and post-event recording capability.

   c. The meter shall have a programmable sampling rate for the waveform recorder.

   d. The meter shall have an advanced DSP design that allows power quality triggers to be based on a 1 cycle updated RMS.

   e. The meter shall allow up to 170 events to be recorded.

   f. The meter shall store waveform data in a first-in, first-out circular buffer to ensure that data is always being recorded.

5. The meter shall include a three-line, bright red, .56” LED display.
   a. The meter shall fit in both DIN 92 mm and ANSI C39.1 round cut-outs.
   b. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.
6. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.
7. Power meter shall include virtual measurement upgrade packs V1 and V2.
   a. Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, and I/O Expansion - V1
   b. Two Megabytes of memory for Data-logging - V2
8. The meter shall include 2 independent communications ports on the back and face plate, with advanced features.
   a. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.
   b. Baud rates shall be from 1200 baud to 57600 baud for the RS485 port.
   c. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a PDA or remote laptop without need for a communication cable.
9. The meter shall provide user configured fixed window or rolling window demand. This shall allow the user to set up the particular utility demand profile.
   a. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
   b. All other parameters shall offer max and min capability over the user selectable averaging period.
   c. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.
   d. The meter shall provide an update rate of every 6 cycles for Watts, VAR and VA. All other parameters shall be every 60 cycles.
10. The meter shall support a power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available and shall have a burden of less than 11 VA. An optional power supply of 18-60 Volts DC shall be available.
11. The meter shall provide Limit Alarms and Control Capability as follows:
    a. Limits can be set for any measured parameter.
    b. Up to 16 limits can be set.
    c. Limits shall be based on % of Full Scale settings.
    d. Manual Relay Control shall be available through software.
    e. Relay set delays and reset delays shall be available.
    f. Relay control shall be available through DNP over Ethernet with the Ethernet Option card.

12. The meter shall have data logging capability with the 2 Megabyte memory. The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created. The meter shall have six logs.
    a. The meter shall have three historical logs for trending profiles. Each log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to allocate memory between the three historical logs in order to increase or decrease the memory allotted to each of the logs.
    b. The meter shall have a log for Limits Alarms. The Limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be capable of recording to 2048 events.
    c. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes, and Critical Data Repairs.
    d. The meter shall have a log for I/O changes. The I/O Change log shall provide a time-stamped record of any Relay Outputs and any Input Status changes. The log must be capable of recording up to 2048 events.
13. The meter shall have I/O expandability through two Option card slots on the back.
    a. The cards shall be capable of being installed in the field, without removing the meter from installation.
    b. The meter shall auto-detect the presence of any I/O Option cards.
    c. The Option card slots shall accept I/O cards in all of the following formats: 100BaseT Ethernet Communication Card; Four Channel Bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Output/4 Status Inputs Card; Fiber Optic Card; IEC 61850 Protocol Ethernet Network Card.
    d. The meter shall be capable of accepting any combination of up to two cards.
        1) When two Ethernet cards are installed in the meter, an independent IPaddress and MAC address shall be assignable to each card.
    e. The Ethernet Option Card shall provide the meter with 100BaseT Ethernet functionality. The Ethernet Option card shall:
        1) Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.
        2) Allow the meter to speak with 5 simultaneous sockets of DNP over TCP/IP so that multiple requests can be handled simultaneously, using standard and optional ports.
        3) Allow the meter to speak with both Modbus TCP and DNP over Ethernet simultaneously.
        4) Allow auto transmit/receive detection for straight or null RJ45 cables.
        5) Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.
        6) Provide email on configured alarms.

7) Provide email notification of meter status and readings data on a programmed schedule.

8) Provide data push of up to 15 meter readings to a cloud server with the JSON structure, such as Lucid BuildingOS®.

9) Provide heightened security by allowing setup of an exclusive TCP/IP client. When the client is communicating though the meter's network card, no other communication to that network card will be allowed, to protect against unauthorized programming.

10) The meter shall be programmable to shut down unused network services to protect against meter tampering.

f. The 1mAO Option Card shall provide the following features:

1) 4 channel, bi-directional 0-1mA outputs.

2) Assignable to any measured parameter.

3) 0.1% of Full Scale accuracy throughout range and load.

4) Maximum load impedance to 10k Ohms, with no accuracy losses.

g. The 20mAO Option Card shall provide the following features:

1) 4 channel, 4-20mA outputs.

2) Assignable to any measured parameter.

3) 0.1% of Full Scale accuracy throughout range and load.

4) Maximum load impedance to 850 Ohms, with no accuracy losses.

5) Loop powered using up to 24 Volts DC.

h. The Relay Output/Status Input Option Card shall provide the following features:

1) 2 Relay outputs, 2 Status inputs.

2) Status Inputs – Wet/Dry Auto Detect up to 150 Volts DC.

3) Trigger on User Set Limits/Alarms (with Virtual Upgrade pack 4).

4) Set delays and Reset delays.

i. The Pulse Output/Digital Input Option Card shall provide the following features:

1) 4 KYZ pulse/4 Status inputs.

2) Programmable to any energy parameter and pulse value.

3) Programmable to End of Interval pulse.

4) Can function for manual relay control and limit based control (with Virtual Upgrade pack 4).

5) 120mA continuous load current.

6) DNP input.

j. The Fiber Optic Option Card shall provide the following features:

1) Built in logic to mimic RS485 half-duplex bus, allowing the user to daisy chain meters for low installation cost.

2) ST Terminated Option.

3) Versatile Link Terminated Option.

4) Modbus and DNP 3.0 protocols available.

k. The IEC 61850 Protocol Ethernet Network Option Card shall provide the following features:

1) Integrates into any IEC 61850 network.

2) Provides support for Modbus and IEC 61850 protocols simultaneously.

3) Configurable for multiple logical nodes.

4) Provides buffered and unbuffered reporting.

5) Provides dual Ethernet IEC 61850 Protocol Network option cards.

6) Is certified by a 3rd party Authorized IEC61850 Test Laboratory.

7) Is capable of supporting two Ethernet /IP connections with separate /IP addresses, each running IEC 61850 protocol.

8) Provide heightened security by allowing setup of an exclusive TCP/IP client. When the client is communicating though the meter's network card, no other communication to that network card will be allowed, to protect against unauthorized programming.

l. Provide meters with Ethernet Option Cards installed.

14. The meter shall have transformer loss, line loss, and total substation loss compensation.

a. Substation losses shall be programmable for Watts and VARs, and for Ferris and Copper losses.

b. The meter shall have CT and PT compensation to set compensation factors for errors in CTs and PTs connected to the meter.

15. The meter shall have a standard 4-year warranty.

16. Power meter shall be able to be stored in (-20 to +70) degrees C.

a. Operating temperature shall be (-20 to +70) degrees C.

b. NEMA 1 faceplate rating shall be available for the power meter.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of metering systems and associated components, such as current and voltage transformers, are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive meters.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Provide grounding and bonding in accordance with specification 26 0526 - Grounding and Bonding for Electrical Systems.

D. Provide fuses complying with single line drawing notes and specification 26 2813 – Fuses.

E. Identify meters and associated wiring in accordance with specification 26 0553 – Identification for Electrical System.

F. Provide all meters with Ethernet Option Cards, as described in Part 2.

3.03 FIELD QUALITY CONTROL

A. Test in accordance with specification 26 0800 - Electrical Testing Requirements.

B. Test and commission meters in accordance with Section 26 0801 Commissioning of Electrical Systems.

C. Correct deficiencies and replace damaged or defective metering system components.

D. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 26 0500 for closeout submittals and additional requirements.

END OF SECTION

SECTION 26 2716 – ELECTRICAL ENCLOSURES FOR CONTROL PANELS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Contactor and relay cabinets.

B. Terminal blocks.

C. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems

C. Section 26 0553 – Identification for Electrical Systems.

D. Section 26 0801 - Commissioning of Electrical Systems.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

C. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks; National Electrical Manufacturers Association.

D. NFPA 70 - National Electrical Code; National Fire Protection Association.

E. CEC – California Electrical Code; Most Recent Addition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosures, associated relays, contactors, and components and accessories.

C. Submit to NEMA ICS 1 indicating control panel layouts, wiring connections and diagrams, dimensions, support points. Include:

1. Dimensioned enclosure layout drawing with size and general layout all internal devices and location for door mounted devices fully annotated.

2. Control wiring diagram fully annotated with wire numbers and device connections shown.

3. Terminal arrangement diagrams.

4. Enclosure, back panel sizes and door latching mechanism.

5. Bill of material listing description, manufacturer, part number and quantity of all items

D. Project Record Documents: Record actual as-built of control wiring in control panels.

1.05 QUALITY ASSURANCE

1. Conform to requirements of CEC.
2. Products for enclosure and associated relays, contactors, and components: Listed and classified by Underwriters Laboratories Inc UL.

PART 2 - PRODUCT

2.01 MANUFACTURERS

A. Enclosure:

1. Rittal
2. Cooper B-Line
3. Pentair Hoffman

2.02 CONTACTOR AND RELAY CABINETS

A. Enclosure Construction:

1. Interior dry locations: NEMA 250 UL 50 Type 1 steel enclosure with butt hinges and latch handle or T-handle.
2. Exterior, wet or damp locations: Same as interior except UL 50 type 3R enclosure with external draw catch quick release latches, gasketed and pad lockable.

B. Enclosure Finish: Manufacturer's standard enamel.

C. Covers: Continuous hinge, held closed by latch kit.

D. Size to suit customized layout and design of components.

E. Provide interior metal back panel for mounting terminal blocks and electrical components, finished with white enamel.

F. Supply sufficient number of neutral terminal blocks to accommodate the total number of circuits shown on the respective cabinet wiring diagrams plus 20% spare. Supply sufficient number of ground bars (interconnected by #8 AWG wire) to accommodate all circuits including dimmer bypassed circuits.

G. PVC cable wiring duct within enclosure shall be minimum 1 3/4" wide x 3" deep secured to back panel with screws.

H. Incoming control circuits fused as noted on drawings, fuses mounted in DIN rail mounted fuse holder.

I. Minimum 3 inch clear wiring space shall be provided above and below the highest and lowest installed device to allow for field wiring entry and exit via PVC wiring ducts.

J. Cabinet layout shall include at least 20% usable spare device spaces on the back panel. The 20% space shall be calculated from the following:

1. The total number of contactors plus the total number of relays plus the total number of other devices plus the total number of terminals. Each of these items shall be rounded up to the nearest whole number and the result of each shall be the number of each respective type of device space(s) provided.

K. Plastic laminated control wiring diagram (minimum 11" high x 8" wide, with 1/8" high text or as cabinet size permits) permanently and securely affixed to the inside of cabinet door. Diagram shall be a complete wiring diagram for the respective cabinet and shall include all devices, wires, and terminals with device designations labeled, device and point numbers labeled, as well as all respective panel and circuit numbers annotated.

L. Device labels shall be secured above of each relay and contactor noting it's designation.

M. Power Terminals above 7 amps NEMA ICS 4: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

N. Signal and Control Terminal blocks NEMA ICS 4 din rail mounted, modular construction type with screw terminals with wire clamp, 600V, 20 amp rated for No. 22 to No. 10 AWG wire, Allen-Bradley Model No. 1492-CD8.

O. Provide ground bus terminal block, with each connector bonded to enclosure.

P. Label all enclosure wiring with wire numbers shown on the project drawings.

2.03 ACCESSORIES

A. Plastic PVC Wide Slot Wiring Duct: Plastic channel with hinged or snap-on cover.

1. Product: Panduit, Thomas & Betts, or Mono Systems Inc.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that mounting surfaces are ready to receive enclosure.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

B. Install enclosures plumb. Anchor securely to wall and structural supports at each corner under the provisions specification 26 0529 Hangers and Supports for Electrical Systems.

C. Provide all nameplates, warning labels and device labels per specification 26 0553 Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. Test and commission controls in accordance with Section 26 0801 Commissioning of Electrical Systems.

B. Correct deficiencies and replace damaged or defective components.

3.04 CLEANING

A. Clean electrical parts to remove conductive and harmful materials.

B. Remove dirt and debris from enclosure.

C. Clean finishes and touch up damage.

END OF SECTION

SECTION 26 2726 – WIRING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Wall plates.

D. Implementation requirements

1.02 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0537 - Boxes.

D. Section 26 0553 - Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification.

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction.

D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.

E. NEMA WD 1 - General Color Requirements for Wiring Devices.

F. NEMA WD 6 - Wiring Devices - Dimensional Specifications.

G. CEC – California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

L. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Operation and Maintenance Data

1. GFCI Receptacles: Include information on status indicators.

E. Project Record Documents: Record actual installed locations of wiring devices.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Notify Owner’s Representative of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing

1. Do not install wiring devices until final surface finishes and painting are complete.

1.06 QUALITY ASSURANCE

A. Conform to requirements of CEC.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Materials and equipment for patching and extending work: As specified in individual sections.

B. Hubbell Incorporated

C. Leviton Manufacturing Company, Inc.

D. Lutron Electronics Company, Inc.

E. Pass & Seymour, a brand of Legrand North America, Inc.

F. Source Limitations: Where possible, provide products for each type of wiring device produced by a single manufacturer and obtained from a single supplier.

G. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

2.02 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified while-in-use weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide tamper resistant receptacles for receptacles installed in dwelling units.

2.03 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: Ivory with ivory nylon wall plate.

C. Wiring Devices Installed in Finished Spaces: Ivory with ivory nylon wall plate.

D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.

E. Wiring Devices Installed in Wet or Damp Locations: White or ivory with specified weatherproof cover.

F. Isolated Ground Convenience Receptacles: Orange.

G. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

2.04 WALL SWITCHES

A. Manufacturers

1. Hubbell Incorporated
2. Leviton Manufacturing Company, Inc.
3. Pass & Seymour, a brand of Legrand North America, Inc.

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Toggle Switch Lock Guard complying with NEMA WD-1 and NEMA WD-6, and listed as complying with UL.

2.05 MANUAL STARTERS

A. Manufacturers

1. Square D
2. Pass & Seymour, a brand of Legrand North America, Inc.
3. Hubbell Incorporated
4. Leviton Manufacturing Company, Inc.

B. Manual Starters: 2-Pole, 20 A, 277 V with toggle switch, lock guard and thermal overload protection as indicated on the drawings.

C. Toggle Switch Lock Guard complying with NEMA WD-1 and NEMA WD-6, and listed as complying with UL.

2.06 RECEPTACLES

A. Manufacturers

1. Hubbell Incorporated.
2. Leviton Manufacturing Company, Inc.
3. Lutron Electronics Company, Inc.; Designer Style.
4. Pass & Seymour, a brand of Legrand North America, Inc.
5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles

1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
2. Isolated Ground Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
4. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
5. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

D. GFCI Receptacles

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
    a. Provide test and reset buttons on device.

b. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

c. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

d. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

e. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.07 WALL PLATES

A. Manufacturers

1. Hubbell Incorporated
2. Leviton Manufacturing Company, Inc.
3. Lutron Electronics Company, Inc.
4. Pass & Seymour, a brand of Legrand North America, Inc.
5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Screws: Metal with slotted heads finished to match wall plate finish.
3. Provide screwless wallplates with concealed mounting hardware where indicated.

C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

E. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

F. Premarked Wall Plates: Factory labeled as indicated; hot stamped for nylon wall plates and engraved for metal wall plates.

G. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

H. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with CEC.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of wiring devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:

   a. Wall Switches: 48 inches above finished floor.

   b. Receptacles: 18 inches above finished floor or 6 inches above counter.

2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.

3. Where multiple receptacles or wall switches are installed at the same location and at the same mounting height, gang devices together under a common wall plate.

4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

K. Install wiring devices plumb and level with mounting yoke held rigidly in place.

L. Install wall switches with OFF position down.

M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

P. Identify wiring devices in accordance with Section 26 0553.

3.04 FIELD QUALITY CONTROL

A. Inspect each wiring device for damage and defects.

B. Operate each wall switch with circuit energized to verify proper operation.

C. Test each receptacle to verify operation and proper polarity.

D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

E. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 2813 – FUSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fuses.

1.02 RELATED REQUIREMENTS

A. Section 26 0573 – Power System Study.

B. Section 26 2818 – Enclosed Switches.

C. Section 26 1319 – Medium-Voltage Metal-Clad Switchgear.

1.03 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association.

B. CEC – California Electrical Code; Most Recent Addition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.

E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses; Current Edition, Including All Revisions.

F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.

G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

C. Medium and high voltage fuses spares: Provide one set(s) of three of each type and size installed.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.

2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.

3. Coordinate fuse requirements shown on single-line drawings and the Owner’s approved coordination study or the Contractor required provided power system study, as applicable to the project scope of work.

4. Notify Owners Representative of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.06 QUALITY ASSURANCE

A. Conform to requirements of CEC.

PART 2 - PRODUCTS

2.01 APPLICATIONS

A. Feeders

1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.

B. General Purpose Branch Circuits: Class RK1, time-delay.

C. Individual Motor Branch Circuits: Class RK1, time-delay.

D. Primary Protection for Control Transformers: Class CC, time-delay.

E. Protection for all voltage sources to power meters: Class CC.

F. 12000V Fuses. E-rated, 15.5kV, sized for full-load current of load.

G. 15.5kV Fuses for Padmount, Liquid-Filled Transformers: Replaceable bay-o-net fuse link in series with current-limiting fuse installed in transformer tank. Both fuses immersed in tank fluid.

2.02 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

H. Class J Fuses: Comply with UL 248-8.

I. Class L Fuses: Comply with UL 248-10.

J. Class CC Fuses: Comply with UL 248-4

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify installed fuses comply with CEC requirements.

C. Verify all installed fuses match the rating and type indicated in the final approved coordination power system study.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

C. Replace all fuses damaged or melted during installation and energization.

D. Provide fuse rating data including type and location installed, in the project close-out documents.

END OF SECTION

SECTION 26 2817 – ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems.

E. Section 26 0573 – Electrical Power System Study.

F. Section 26 0800 - Electrical Testing Requirements.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. CEC – California Electric Code; Most Recent Addition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

E. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

F. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

H. UL 869A – Reference Standard for Service Equipment, Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of circuit breaker upon request.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Clearly indicate short circuit current ratings are fully rated. All circuit breakers must be fully rated for the short circuit current noted on one line and calculated in Section 26 0573 – Electrical Power System Study.

D. Field Quality Control Test Reports.

E. Project Record Documents: Record actual installed locations of enclosed circuit breakers.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and to maintain working clearances required by CEC.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Notify Owner Representative of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.06 QUALITY ASSURANCE

A. Conform to requirements of the CEC, particularly for wire bending space within enclosure.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General Electric Company

B. Schneider Electric; Square D Products

C. Eaton Corporation

2.02 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.

2. Ambient Temperature: Between 23 degrees F and 104 degrees F.

D. Short Circuit Current Rating:

1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location and calculated in Section 26 0573 – Electrical Power System Study.

E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as Service Equipment according to UL 869A.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

H. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied gray unless otherwise indicated.

3. Provide surface-mounted enclosures unless otherwise indicated.

J. Provide externally operable handle with means for locking in the OFF position.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Breakers with pad locking provisions.

C. Breakers shall be UL listed for reverse feed.

D. Breakers shall be 100% rated as indicated on the single lines diagrams.

E. Provide separate neutral current sensor for breakers with built in ground fault protection where neutral cables are used.

F. Provide accessories as indicated on drawings for shunt trip, undervoltage release, auxiliary status switch, and/or alarm switch indicating when circuit breaker has tripped.

G. Conductor Terminations:

1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

H. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

I. Breaker types:

1. Thermal Magnetic molded case breakers for amp frames of 150 or less, UL listed. For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

2. Electronic Trip Circuit Breakers molded case with electronic sensing, timing and tripping circuits for adjustable current settings; UL listed. All frames from 225A to 1200A unless otherwise noted shall use field installed rating plugs (70A to 1200A) or with field changeable trip units to establish or change the ampere rating. Digital microprocessor trip system shall be applicable for 60Hz systems and shall accurately sense sinusoidal and non-sinusoidal current waveforms (fundamental through the thirteenth harmonic order on a 60Hz base) by continuously sampling each phase throughout life cycle. Breakers shall function normally at up to 95% relative humidity, non-condensing.

3. Electronic Trip Circuit Breakers molded case style breakers, with solid state, amperage display, microprocessor-based, true rms sensing as identified on single-line diagrams as LSI or LSIG or larger than 1200A frame. Breakers as molded case style with electronic sensing, timing and tripping circuits for adjustable current settings; All frames from 100A to 4000A shall use field installed rating plugs (15A to 4000A) or with field changeable trip units to establish or change the ampere. Digital microprocessor trip system shall be applicable for 60Hz systems and shall accurately sense sinusoidal and non-sinusoidal current waveforms (fundamental through the thirteenth harmonic order on a 60Hz base) by continuously sampling each phase throughout life cycle. Breakers shall function normally at up to 95% relative humidity, non-condensing. Display to provide cause of trip and the value at the time of trip.

   a. Provide the following field-adjustable trip response settings:

      1) Instantaneous trip settings.

      2) Short time trip settings.

      3) Short time delay setting of I^2T in and out.

      4) Long time trip settings.

      5) Long time delay settings.

      6) LSIG trip unit shall include ground fault pickup settings.

      7) LSIG trip unit shall have time delay setting of I^2T in and out.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor to:

1. Verify that field measurements are as indicated.

2. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

3. Verify mounting surfaces are ready to receive enclosed circuit breakers.

4. Verify that working clearance, access, and installation conditions are satisfactory prior to starting work.

3.02 INSTALLATION

A. Install enclosed circuit breakers in accordance with manufacturer's instructions.

B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and CEC.

D. Provide required supports in accordance with Specifications 26 0529 Hangers and Supports for Electrical Systems and seismic restraints and mounting per 26 0548 Vibration and Seismic Controls for Electrical Systems.

E. Install enclosed circuit breakers plumb.

F. Provide grounding and bonding in accordance with Specification 26 0526 Grounding and Bonding for Electrical Systems.

G. Install equipment identification nameplate in accordance with Specification 26 0553 Identification for Electrical System.

H. Install an arc flash hazard label based on the final approved power system study.

3.03 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer’s recommended torque settings.

3.04 FIELD QUALITY CONTROL

A. Test circuit breakers in accordance with Specification 26 0800 Testing Requirements.

B. Correct deficiencies and replace damage or defective enclosed circuit breakers and associated components.

3.05 CLEANING

A. Clean dirt and debris from enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 2818 – ENCLOSED SWITCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Enclosed Fusible safety switches.

B. Enclosed Non Fusible safety switches.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0548 – Vibration and Seismic Controls for Electrical Systems.

D. Section 26 0553 – Identification for Electrical Systems: Nameplates

E. Section 26 0753 – Electrical Power System Study.

F. Section 26 2813 – Fuses.

1.03 REFERENCE

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); National Electrical Manufacturers Association.

D. CEC – California Electric Code; Most Recent Addition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

E. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

F. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

G. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

H. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

C. Shop Drawings: Indicate enclosure and support point dimensions, voltage and current ratings, short circuit ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

D. Project Record Documents: Record actual locations of enclosed switches.

1.05 QUALITY ASSURANCE

A. Conform to requirements of California Electrical Code.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

C. Product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacture's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General Electric

B. Schneider Electric; Square D Products

C. Eaton Corporation

D. Killark (NEMA Type 7)

E. Appleton (NEMA Type 7)

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; lockable, heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).

2. Ambient Temperature: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

C. Horsepower Rating: Suitable for connected load.

D. Voltage Rating: Suitable for circuit voltage.

E. Short Circuit Current Rating

1. Enclosed safety switches shall be protected by the fuses or supply side overcurrent protective devices with short circuit current rating not less than the available fault current at the installed location as indicated on the Owner's approved coordination study or the Contractor required provided power system study, as applicable to the project scope of work.

F. Provide with switch blade contact position that is visible when the cover is open.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Provide insulated, fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250:

a. Interior Dry Locations: Type 1

b. Exterior Locations: Type 3R

c. Hazard locations and corrosive environments: Type 7

d. Always wet or subject to periodically wet conditions such as cooling tower area and kitchens: Type 4X (IP 66) Stainless Steel 316

2. Finish for Steel Enclosures: Manufacture’s standard, factory applied grey.

K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

L. Heavy Duty complies with NEMS KS 1.

M. Provide operable handle with Padlock provisions for locking in the OFF position.

N. Provide with auxiliary contact switch if noted on the drawings. Auxiliary switch of SPDT type and suitable for connection to system indicated. Switch to provide status of the switch blades open and closed.

O. Provide with viewing window in door if window is noted on drawings. Window to be positioned for visual confirmation of contact positions with cover door closed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install enclosed switches in accordance with manufacturer's instructions.

B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and CEC.

D. Provide required supports in accordance with Section 26 0529 Hangers and Supports for Electrical Systems and seismic restraints and mounting per Section 26 0548 Vibration and Seismic Controls for Electrical Systems.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 0526 Grounding and Bonding for Electrical Systems.

H. Provide fuses complying with Section 26 2813 Fuses for fusible switches as indicated or as required by equipment manufacturer’s recommendations.

I. Install equipment identification nameplate in accordance with Section 26 0553 Identification for Electrical System.

J. Install an arc flash hazard label based on the final approved power system study, or in accordance with NFPA 70E where not covered by a power system study.

3.02 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer’s recommended torque settings.

3.03 FIELD QUALITY CONTROL

A. Test in accordance with Section 26 0800 Testing Requirements.

B. Correct deficiencies and replace damage or defective enclosed safety switches and associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer’s recommended torque settings.

B. Operate switch and verify proper switch action for both open and closed operation.

3.05 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 5100 – INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.

B. Exit signs.

C. Luminaire accessories.

1.02 RELATED REQUIREMENTS

A. Section 26 0537 - Boxes.

B. Section 26 0553 - Identification for Electrical Systems.

C. Section 26 2726 - Wiring Devices.

1.03 REFERENCE STANDARDS

A. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).

B. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.

C. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.

F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.

G. CEC - California Electric Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

H. NFPA 101 - Life Safety Code; 2015.

I. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

J. UL 1598 - Luminaires; Current Edition, Including All Revisions.

K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

2. Provide photometric calculations where luminaires are proposed for substitution upon request.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories,

and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:

   a. Include estimated useful life, calculated based on IES LM-80 test data.

2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.

D. Field Quality Control Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

G. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.05 QUALITY ASSURANCE

A. Conform to requirements of CEC.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 WARRANTY

A. Comply with Section 26 0500 for additional warranty requirements.

B. Provide three-year manufacturer warranty for all LED luminaires, including drivers.

PART 2 - PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of CEC.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including LED's, drivers, housings, wire guards, and other components required to position, energize and protect the LED array and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.

2. Tested in accordance with IES LM-79 and IES LM-80.

3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EXIT SIGNS

A. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

1. Number of Faces: Single or double as indicated or as required for the installed location.

2. Directional Arrows: As indicated or as required for the installed location.

2.04 LED DRIVERS

A. Ballasts/Drivers - General Requirements:

1. Minimum Efficiency/Efficacy: Provide drivers complying with all current applicable federal and state driver efficiency/efficacy standards.

2.05 ACCESSORIES

A. 360 degree high mount occupancy sensor.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with CEC.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.

2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.

3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet (1.2 m) between supports.

4. Install canopies tight to mounting surface.

5. Unless otherwise indicated, support pendants from swivel hangers.

F. Install accessories furnished with each luminaire.

G. Bond products and metal accessories to branch circuit equipment grounding conductor.

H. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from the inverter feeding lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

2. Install lock-on device on branch circuit breaker serving units.

I. Fixture Burn-In: Operate fixture at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace fixtures that fail prematurely due to improper lamp burn-in.

3.03 FIELD QUALITY CONTROL

A. Comply with Section 26 0500 for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy fixtures as determined by Engineer.

3.04 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. Just prior to Substantial Completion, replace all fixtures that have failed.

3.06 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 26 5600 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.

B. Drivers.

C. Poles and accessories.

D. Luminaire accessories.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0537 - Boxes.

1.03 REFERENCE STANDARDS

A. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing.

B. IEEE C2 - National Electrical Safety Code.

C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low Voltage (1000V or less) AC Power Circuits.

D. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.

E. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products.

F. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction.

H. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems.

I. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers.

J. CEC - California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 1598 - Luminaires; Current Edition, Including All Revisions.

L. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Shop Drawings

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

2. Provide photometric calculations where luminaires are proposed for substitution upon request.

3. Provide structural calculations for each pole proposed. Calculations to include existing structural footing.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires

a. Include estimated useful life, calculated based on IES LM-80 test data.

b. Include IES LM-79 test report upon request.

2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.

3. Arrays: Include rated life and initial and mean lumen output.

4. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

D. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.

E. Field Quality Control Reports

1. Include test report indicating measured illumination levels.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

H. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.06 QUALITY ASSURANCE

A. Conform to requirements of CEC.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 WARRANTY

A. Provide three-year manufacturer warranty for all LED luminaires, including drivers.

PART 2 - PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products in accordance with Campus Standards as indicated on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of CEC.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including array(s) and all sockets, drivers, reflectors, lenses, housings and other components required to position, energize and protect the array and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

H. LED Luminaires

1. Components: UL 8750 recognized or listed as applicable.

2. Tested in accordance with IES LM-79 and IES LM-80.

3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

I. Exposed Hardware: Die-cast aluminum housing.

2.03 DRIVERS

A. Drivers - General Requirements

1. Minimum Efficiency/Efficacy: Provide drivers complying with all current applicable federal and state driver efficiency/efficacy standards.

2. Electronic Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

2.04 ARRAYS

A. Arrays - General Requirements

1. Unless explicitly excluded, provide new, compatible, operable arrays in each luminaire.
2. Verify compatibility of specified arrays with luminaires to be installed. Where arrays are not specified, provide arrays per luminaire manufacturer's recommendations.
3. Minimum Efficiency: Provide arrays complying with all current applicable federal and state array efficiency standards.
4. Color Temperature Consistency: Unless otherwise indicated, for each type of array furnish products which are consistent in perceived color temperature. Replace arrays that are determined by the Engineer to be inconsistent in perceived color temperature.

2.05 POLES

A. All Poles

1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
2. Structural Design Criteria:
   a. Comply with AASHTO LTS.
   b. Wind Load: Include effective projected area (EPA) of luminaire(s) and associated supports and accessories to be installed.
   c. Dead Load: Include weight of proposed luminaire(s) and associated supports and accessories.
3. Material: Steel, unless otherwise indicated.
4. Shape: Round, unless otherwise indicated.
5. Finish Color: RAL 7003, unless otherwise indicated.
6. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
7. Unless otherwise indicated, provide with the following features/accessories:
   a. Top cap.
   b. Anchor base cover.
   c. Brackets: Per manufacturer.
   d. Hinged base.
   e. Pole-top tenon, 4-inch.
   f. Round pole-mounted occupancy sensor
   g. Button Photocell

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that suitable support frames are installed where required.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products according to manufacturer's instructions.

B. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).

C. Pole-Mounted Luminaires:

1. Maintain the following minimum clearances:

a. Comply with IEEE C2.

2. Foundation-Mounted Poles

a. Insure foundations are plumb.

b. Tighten anchor bolt nuts to manufacturer's recommended torque.

c. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.

d. Install anchor base covers or anchor bolt covers as indicated.

3. Grounding

a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.

4. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.

5. Install non-breakaway in-line fuse holders and fuses complying with Section 26 2813 in pole handhole or transformer base for each ungrounded conductor.

6. Poles are to be mounted on concrete footings using anchor bolts. Provide custom made base plate.

D. Install accessories furnished with each luminaire.

E. Bond products and metal accessories to branch circuit equipment grounding conductor.

F. Install arrays in each luminaire.

3.03 FIELD QUALITY CONTROL

A. Inspect each product for damage and defects.

B. Operate each luminaire after installation and connection to verify proper operation.

C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy drivers as determined by Engineer.

D. Measure illumination levels at night with calibrated meters to verify conformance with performance requirements. Record test results in written report to be included with submittals.

3.04 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Engineer.

3.05 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or adjust as directed.

B. Just prior to Substantial Completion, replace all arrays that have failed.

3.07 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 0500 – COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Drawings and provisions of the Contract including Division 26 Electrical apply, except where supplemented by this Section.

C. Section 26 0500 – Common Work Results for Electrical

D. Section 27 1323 – Communications Optical Fiber Cabling

1.02 CODE AND STANDARDS

A. The following codes, associations, acts and agencies, as required by law:

1. Federal Communications Commission (FCC)
2. California Code of Regulations, Title 24, Part 3, California Electrical Code
3. Occupational Safety and Health Administration (OSHA)

B. The current edition of the following standards:

1. California State University Telecommunications Infrastructure Planning Standards
2. TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-568-C.4
3. TIA-569-C
4. TIA-606-B
5. J-STD-607
6. IEEE Standard 80
7. IEEE Standard 81
8. IEEE Standard 525
9. IEEE Standard 693
10. IEEE Standard 1379

C. The current edition of the following guidelines:

1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
3. BICSI, Outside Plant Design Reference Manual (OSPDRM)
4. BICSI/NECA-568
5. BICSI/NECA-607

1.03 SUMMARY

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. This Section includes

1. Cable Routing, Separation, and Distance

2. Common Installation Requirements

C. All references to Division 26, contained herein, are the responsibility of the Contractor.

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. Product Date for equipment rack and catalog pages and data sheets.

1.05 DEFINITIONS

A. Advanced System Warranty – an extended telecommunications warranty (20 years or greater) held by either the connectivity or cabling manufacturer directly with the Owner for a project that guarantees product and performance of the entire cabling system for the warranty period. Refer to Warranty Requirements in Quality Assurance sub-section of this specification for additional information and requirements.

B. Asbestos Containing Material (ACM) - any material containing more than one percent (1%) asbestos.

C. Backbone (Riser) Cabling – The cabling that connects multiple Telecommunications Rooms to each other, to the Equipment Room and/or to the Entrance Facility.

D. Communications Outlet (Work Area Outlet) – Any point of connectivity for voice, data, or video services at the users end. (i.e. work area, desk, etc.)

E. Communications Pathways – Conduits, cable trays or other supports with the sole purpose of carrying communications cabling.

F. Conveniently Accessible – being capable of being reached from the floor or with the use of an 8-foot step ladder without climbing or crawling over or under obstacles such as motors, pumps, belt guards, transformers, piping and/or duct work.

G. Design Engineer – the company as defined for sections referring to telecommunications work only, the Design Engineer shall be the design consultant contracted by the Owner.

H. Entrance Facility (telecommunications, EF) – An entrance to a building for both public and private network service cables (including wireless) including the entrance point of the building and continuing to the entrance room or space. The location where the main telecommunications service enters a building from the outside; where the demarcation between the inter-building and intra-building cabling system occurs.

I. Equipment Room (telecommunications, ER) – An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect. The location which provides space and maintains a suitable operating environment for large telecommunications equipment. This space may be co-located with the Entrance Facility and/or Telecommunications Room, provided the room is sized for all functions.

J. Horizontal Cabling – The cabling between the Telecommunications Room and the Work Area that carries voice, data and/or video signals.

K. Horizontal Cross-connect (HC) – A cross-connect of horizontal cabling to other cabling, e.g. horizontal, backbone, equipment. A connection facility that is cabled between the equipment outlet and the intermediate cross-connect in a hierarchical star topology (e.g. Telecommunications Room).

L. Inside Plant (ISP) Cabling – Communications cabling and terminations primarily located inside the building footprint including, but not limited to copper and optical fiber cabling, splicing and terminations, and work related to their construction.

M. Inside Plant (ISP) Pathways – Communications pathways primarily located inside the building footprint including but not limited to conduits, j-hooks, cable trays, enclosures, equipment racks and cabinets, and work related to their construction.

N. Lead Telecommunications Installer – acting as the project manager for the Telecommunications Subcontractor for all telecommunications work in the construction documents (telecommunication drawings and Division 27 project specifications), who shall be on-site at all times while Division 27 work is being performed. This individual shall attend all construction project meetings. Refer to this specification for required qualifications of this individual.

O. Nationally Recognized Testing Laboratory (NRTL) – a testing facility recognized by the Occupational Safety and Health Administration (OSHA) as primarily private sector organizations that provide product safety testing and certification services to manufacturers.

P. Outside Plant (OSP) Cabling – Communications cabling and terminations primarily located outside the building footprint including, but not limited to copper and optical fiber cabling, splicing and terminations, lightning and electrical protection, and work related to their construction.

Q. Outside Plant (OSP) Pathways – Communications pathways primarily located outside the building footprint including but not limited to conduits, maintenance holes, hand-holes and work related to their construction.

R. Plenum-rated – listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP.

S. Substantial Completion – The stage in the progress of the Work where the Work or designated portion is sufficiently complete and the Owner can utilize the Work for its intended use. The point during construction at which the contractor is ready to turn the project over to the Owner for acceptance and final punch list. The Owner must receive and approve optical fiber and copper test results before any project may be deemed substantially complete.

T. Telecommunications Room (TR) –The location where the connection between the horizontal cabling and the building backbone cabling occurs. This room also contains the electronic equipment that transitions between the data, voice and video building backbone and the end user's telecommunications equipment. This space may be co-located with the Entrance Facility and/or Equipment Room, provided the room is sized for all functions.

U. Telecommunications Space – An area or room dedicated for use for the telecommunications infrastructure and equipment (e.g. Entrance Facility, Equipment Room, Telecommunications Room, Maintenance Hole, Handhole).

V. Telecommunications Subcontractor – the company responsible for all telecommunications work in the construction documents (telecommunication drawings and Division 27 project specifications).

W. Wet Location – Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

X. Furnish – To supply and deliver to the project site ready for instruction. This includes supplying and delivering to project site, ready for unloading, unpacking, assembly, installation, and similar operations.

Y. Install – To place in position for service or use. This includes operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

Z. Provide – Furnish and install, complete and ready for the intended use.

1.06 OTHER ACRONYMS & ABBREVIATIONS

A. Refer to Division 1 and Division 26 Section 26 0500.

1.07 COORDINATION WITH OTHER TRADES

A. Coordinate layout of work with other trades. Make minor adjustments in location required for coordination. Locations of structural systems, heating work and plumbing lines shall take preference over locations of conduit lines where conflict occurs. Structural systems, heating work, and plumbing lines shall not interfere with or otherwise impede the routing of communication cabling with cable tray, raceways, or other pathways dedicated to communications. All potential issues shall be brought to the attention of the Owner immediately, before proceeding with installation.

B. Other than minor adjustments shall be submitted to the Owner for approval before proceeding with the work.

C. Coordinate locations, arrangement, mounting, and support of all communications provisions with Division 26.

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.

4. So that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

D. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

E. Coordinate sleeve selection and application with selection and application of firestopping, if needed, as specified in Division 07 and Division 26.

F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

G. The location of Telecommunication Outlets shown on the Drawings is approximate, and the Owner shall have the right to relocate any Telecommunication Outlets before they are installed without additional cost.

1.08 SUBMITTALS

A. Refer to Division 1 and 26 0500 for project submittal requirements.

B. Product Data Sheets.

C. Qualification data for firms and persons to demonstrate their capabilities and experience.

1.09 QUALITY ASSURANCE

A. Any changes in conditions and designated systems require the Owner' prior approval. Submit documentation showing that the performance of proposed substitutions equals or exceeds that of the systems they would replace and are acceptable to authorities having jurisdiction.

B. Telecommunications Installer Qualifications

1. Telecommunications Installers (TIs) shall have responsibility for the coordination and installation of the work shown and described in the telecommunications drawings and specifications.

2. Telecommunications Installer Requirements

   a. The Telecommunications Installer shall certify in writing and provide supporting documentation to support that the Lead Telecommunication Installer is BICSI ITS Technician Certified and has a minimum of five (5) years of experience installing similar telecommunications systems.

   b. If the scope of work requires outside cable plant installation (conduits and/or cabling), the contractor performing these tasks shall have five (5) years' experience.

3. The Telecommunications Installer shall comply with all manufacturers recommended installation instructions/procedures for all installations unless otherwise noted in the scope of work, drawings or specifications.

4. The Telecommunications Installer shall inspect each item, material or piece of equipment, upon receipt, prior to installation and reject damaged and defective items.

5. General Telecommunications Installer Requirements

   a. For all work associated with Division 27, all installers are to have a minimum of BICSI ITS Installer 1 Training.

   b. Advanced training from connectivity manufacturer may be submitted in lieu of BICSI ITS Installer 1 training. Submit manufacturer-training certificates for review by the Owner as substitution request.

6. General Telecommunications Installers shall have an OSHA 10-hour Construction Card as evidence of completing an OSHA approved 10-hour training program. Submit a copy the OSHA 10-hour Construction Card for each individual.

C. Warranty Requirements

1. Project Warranty

   a. Equipment and materials required for installation under these standards shall be the current model and new (less than one (1) year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect for a minimum of one (1) year from the date of project acceptance by the Owner.

   b. When a defect or problem is observed within the first year after substantial completion, the Owner will notify the Contractor through the proper channels. The Contractor then will have 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or the Owner.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job site.

B. Comply with recommended procedures, precautions or remedies described in Material Safety Data Sheets as applicable.

C. Do not use or install damaged or expired materials.

1.11 SEQUENCING

A. Sequence Work to permit communication equipment and materials to be installed after adjacent and surrounding work is complete.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Hangers and Supports

1. Cooper B-Line
2. Erico/Caddy
3. Panduit Corporation

2.02 EQUIPMENT RACKS

A. Equipment Racks Provided in Switchgear Building shall be minimum of 18U, wall-mount 19" wide, 24.5" deep racks, with hinged swing out, lockable hinged door and perforated walls.

B. Vented front and vented side panels.

C. Fan grill made ready for cooling fans.

D. For IT rack:

1. Provide power strip in rack connected to powered by roomy panel. Circuit as noted on drawings.
2. Provide swingout hinge on the right.

E. For SCADA

1. Provide swingout hinge on the left.
2. Coordinate Height of 26U with SCADA equipment manufacture.

F. Tripp-Lite SRW18USDP, SRW26USDP or approved equal.

2.03 REFERENCE PART NUMBERS

A. Bidder shall confirm all reference part numbers, listed within Division 27, as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies prior to bidding.

B. All materials associated with reference parts shall be included so as to constitute a complete and functional system, whether or not specifically identified, itemized, and quantified

2.04 FIRE STOPPING

A. Comply with Division 7 requirements.

PART 3 - EXECUTION

3.01 FIELD CONDITIONS

A. Examine all elements intended for Communications. Check pathways, raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, installation hazards or impediments, and other conditions affecting installation. Proceed with installation

only after unsatisfactory conditions and discrepancies have been brought to the attention of the Owner and corrected.

B. Unless otherwise noted, the footages for cabling and materials shown on the Project Drawings are based upon available plant records, site plan drawings, or the Engineer's route and pathway assumptions. The Contractor shall be required to perform field surveys and measurements, prior to ordering materials.

3.02 COMMON INSTALLATION REQUIREMENTS

A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall mounting items.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

D. Right of Way: Give to piping systems installed at a required slope.

E. The Contractor shall contact Owner before commencement of work and shall coordinate with Owner personnel and all other trades

3.03 CABLE ROUTING, SEPARATION, AND DISTANCE

A. Whenever possible, primary cable routing paths shall follow the logical structure of the building. When a wall must be breached, provide sleeved openings. Cabling shall enter and exit these areas at 90° angles. Route all cables and cable raceways parallel to or perpendicular to building structure. No diagonal runs shall be permitted, unless noted otherwise.

B. To reduce or eliminate the field effect of EMI on data signaling, cable runs shall be kept a minimum distance from EMI sources.Refer to ANSI/NECA/BICSI-568-2006 Standard for Installing Commercial Building Telecommunications Cabling.

1. Minimum separation distance from possible sources of EMI:

a. 5 inches (125mm) from power lines of 2 KV or less.

b. 12 inches (305mm) from lighting fixtures.

c. Minimum separation distance from possible sources of EMI exceeding 4KV:

Condition	Min. Separation Distance
Unshielded power lines or electrical equipment in proximity to open or non-metal pathways.	24 in. (610 mm)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	12 in. (300 mm)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	6 in. (150 mm)
Electrical motors and transformers.	47 in. (1200 mm)

C. Communications cabling shall not be run in parallel with any high voltage electrical wiring, unless specifically intended for control equipment of high voltage electrical wiring, and specified by the control equipment manufacturer.

D. The maximum length of horizontal communications cables shall be limited to 90 meters from the Telecommunications Outlet to the point of termination.

E. All cabling shall be installed as single continuous homerun pulls from Connector Block to Patch Panel, and Telecommunications Outlet to Patch Panel. No inline connectors or splices in any form shall be permitted.

F. Cable routing from the Cable Runway onto the distribution frame shall be neatly organized and supported by cable support brackets, clips, loops, radius drops, spools, etc., as required to minimize tension and stress on the connector block terminations.

3.04 FIRE STOPPING

A. Refer to Division 07 for installation requirements.

3.05 PROTECTION OF FINISHED WORK

A. Protect equipment and materials from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated materials immediately and install new materials complying with specified requirements.

END OF SECTION

SECTION 27 0526 – GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Grounding and bonding systems are an integral part of the communications cabling system. In addition to helping protect personnel and equipment from hazardous voltages, a proper grounding and bonding system will improve the electromagnetic compatibility performance of the cabling system. Improper grounding and bonding can allow induced voltages and conducted noise, which can disrupt signal transmission. The telecommunications grounding and bonding system shall conform to local codes and TIA-STD-607-B requirements.

B. Description of work

1. Furnish and install a complete and fully-functioning grounding and bonding system. All cables, terminations, support hardware, and grounding and bonding hardware shall be furnished, installed, tested, labeled, and documented by the telecommunications subcontractor.

a. Coordinate with electrical contractor including pathways, termination points, busbar locations, and connections to the main electrical service ground and electrical distribution panels.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 26 0500 Common Work Results for Electrical, for material submittal requirements.

C. Section 26 0526 Grounding and Bonding for Electrical Systems including all referenced codes, standards and guidelines.

1.03 REFERENCE STANDARDS

A. IEEE Standard 80

B. IEEE Standard 81

1.04 DEFINITIONS

A. BCT: Bonding Conductor for Telecommunications. A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

B. Bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

C. EMT: Electrical metallic tubing.

D. GE: Grounding equalizer. The conductor that interconnects elements of the telecommunications grounding infrastructure. For example, a bonding conductor that interconnects TGBs on the same floor.

E. Ground: A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

F. RGC: Rack Bonding Conductor. A bonding conductor used to connect an equipment rack directly to the TMGB or TGB.

G. RGB: Rack Bonding Busbar. A busbar that is vertically mounted on an equipment rack.

H. TBB: Telecommunications bonding backbone. A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar (TGB) located on the floor farthest away.

I. TGB: Telecommunications grounding busbar. A common point of connect for telecommunication systems and equipment bonding to ground and located in the telecommunications rooms (TR) and equipment room (ER).

J. TMGB: Telecommunications main grounding busbar. A busbar placed in a convenient and accessible location and bonded, by means of the BCT, to the building ac service equipment (power) ground.

1.05 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Division 01:

1. Product Information

a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.

b. Provide manufacturer's product information cut-sheet or specifications sheet with the specific product number identified.

C. Shop Drawings

1. Provide scaled drawings indicating the location and size, dimensions, type of connection (e.g. mechanical, exothermic weld of each bonding busbar (e.g., TMGB, TGB), conductor (e.g., BCT, GE, TBB), connections (e.g., lugs), and splice points.

2. Provide scaled plan and elevation drawings (not less than 1/4" = 1'-0") indicating locations of busbars (e.g. TMGB, TGB, RGB).

D. The following submittals are due at the Post-Construction Phase, in accordance with submittal requirements in Division 01:

1. Record Drawings

a. Provide scaled drawings (floor plans not less than 1/16" = 1'-0") indicating actual location and size/length of TMGB, TGBs, BCT, GE and TBB conductors and all splice points.

b. Provide scaled plan and elevation drawings (not less than 1/4" = 1'-0") indicating actual locations of TMGB and TGBs.

c. Provide manufacturer's product information cut-sheet or specifications sheet with the specific product number identified.

2. A letter from the contractor stating that the grounding system has been installed in accordance with the project documents and the referenced codes, standards, and guidelines. This letter is to also specifically acknowledge that the telecommunications grounding system has been fully tested according to these specifications.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

PART 2 - PRODUCTS

2.01 GENERAL

A. All components shall be listed by a NRTL.

B. Telecommunications grounding systems installed on this Project shall conform to J-STD-607-B and the following guidelines, whichever is more stringent.

2.02 CONDUCTORS

A. Conductors shall be copper. Bare and insulated conductors are permitted. The CEC specifies criteria for mechanical protection.

B. Conductors shall comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

2. Cable Tray Equipment Grounding Wire: No. 6 AWG

D. Cable Tray Grounding Jumper

1. Not smaller than No. 6 AWG and no longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor

6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 COMPRESSION LUGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Harger Lightning and Grounding

2. Hubbell

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with CEC for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Type

D. Two holes with various hole spacings to fit the busbar.

E. Long barrel that will allow a minimum of two crimps with standard industry colors.

F. An inspection window to verify that the conductor is fully seated in the lug.

G. Crimped according to manufacturer's recommendation.

2.04 TAPS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Harger Lightning and Grounding
2. Hubbell

B. Connections to the conductor shall be made with irreversible compression connectors listed for the purpose. Listed by an NRTL as complying with CEC for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Shall be able to accept 6 AWG to 3/0.

D. Shall require a minimum of two (2) crimps for C Tap and H Tap, one (1) crimp for I-Beam and busbar Tap.

E. Crimp according to manufacturer's recommendation.

F. C Tap

1. Main Run 6-4 AWG - Tap 6 AWG
   a. Hubbell Part Number HYC4C6 or approved equal
2. Main Run 6-4 AWG – Tap 4 AWG
   a. Hubbell Part Number HYC4C4 or approved equal
3. Main Run 2 AWG – Tap 8-4 AWG
   a. Hubbell Part Number HYC2C4 or approved equal
4. Main Run 2 AWG – Tap 2 AWG
   a. Hubbell Part Number HYC2C2 or approved equal
5. Main Run 1/0-2/0 AWG – Tap 8-2 AWG
   a. Hubbell Part Number HYC26C2 or approved equal
6. Main Run 1/0-2/0 AWG – Tap 1/0-2/0 AWG
   a. Hubbell Part Number HYC26C26 or approved equal

G. H Tap

1. Main Run 4/0-2 AWG - Tap 2-8 AWG
   a. Hubbell Part Number HYH292C or approved equal
2. Main Run 2-8 AWG – Tap 2-8 AWG
   a. Hubbell Part Number HYH2C2C or approved equal
3. Main Run 6-10 AWG – Tap 6 AWG
   a. Hubbell Part Number HYH6C6C or approved equal

H. Busbar Tap

1. Busbar thickness .25", Main Run 2 AWG - Tap 6 AWG
   a. Hubbell Part Number HYG14B2TC2C6C or approved equal
2. Busbar thickness 0.25", Main Run 2 AWG – Tap 2 AWG
   a. Hubbell Part Number HYG14B2TC2C2C or approved equal

3. Busbar thickness 0.25", Main Run 4/0 – 1/0 AWG

   a. Hubbell Part Number HYGBTC28 or approved equal

2.05 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Pentair/ERICO.
2. Hubbell.
3. Or Approved Equal

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4-inch by 4-inches in cross section and at minimum 20-inches long. Increase length as necessary to provide all connections with 25% spare capacity. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.

1. A TMGB shall be provided at the telecommunications service entrance (or as indicated on the drawings).
2. Predrilling shall be with holes for use with lugs specified in this section.
3. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
4. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for us in 600-V switchboards, impulse tested at 5000V.

C. TGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4-inch by 2-inches in cross section and at minimum 12-inches long. Increase length as necessary to provide all connections with 25% spare capacity. The busbar shall be NRTL listed for use as TGB and shall comply with J-STD-607-B.

1. A TGB shall be provided in each telecommunications room.
2. Predrilling shall be with holes for use with lugs specified in this section.
3. Mounting Hardware: Stand-off brackets that provide a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
4. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for us in 600-V switchboards, impulse tested at 5000V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-B. Predrilling shall be with holes for use with lugs specified in this section.

1. Rack-Mounted Vertical Busbar: Minimum 36-inches long with stainless-steel or copper plated hardware for attachment to the rack.

2.06 GROUND RODS

A. Ground Rods: Copper-clad Stainless-steel; 3/4 inch in diameter by 10 feet in length minimum.

2.07 LADDER RACK BONDING CONDUCTORS

A. Ground cord assembly

1. Stranded THHN
2. Color: green

3. #6 AWG insulated bonding jumper
4. Length: 9” - 12”.
5. Each end terminated with a two hole compression lug or listing approved terminal
6. Hubbell Part Number HGRKTD12D, HGRKTKA9KA5, HGRKTKLU9KLU5 or approved equal.

B. Braided Jumper

1. 0.94” Braid width
2. Hole diameter 0.375”
3. Hole Spacing 1.25”
4. Length: 12”
5. Hubbell Part Number HGBBD12 or approved equal

2.08 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch. Overlay shall provide weatherproof and UV-resistant seal for label.

C.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that abandoned wiring and equipment serve only abandoned facilities.

B. Report discrepancies to Engineer before disturbing existing installation.

C. Beginning of demolition means Contractor accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from Owner at least 4 weeks before partially or completely disabling system.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove abandoned wiring to source of supply.

C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

E. Disconnect and remove abandoned panelboards and distribution equipment.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

H. Provide cover plates to cover holes in trenches when equipment is removed.

3.04 CLEANING AND REPAIR

A. Comply with provisions of Section 26 0500.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

END OF SECTION

SECTION 27 0533 – CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This section governs the products and installation of conduits, back boxes, and additional accessories, connections, fittings, and equipment required for in-building communications systems, otherwise known as “Electrical Rough-in”.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 26 0500 Common Work Results for Electrical, for material submittal requirements.

C. Section 26 0535 Surface Raceways.

1.03 DEFINITIONS

A. Conveniently Accessible – being capable of being reached from the floor or use of 8-foot step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and duct work.

B. Listed Communications Cable – A cable listed by a Nationally Recognized Testing Laboratory (NRTL) and acceptable to the local Authority Having Jurisdiction (AHJ) as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to CEC Articles 725, 770, and 800 for listing types and additional requirements. Assume Outside Plant (OSP) Cables being supplied are not Listed.

C. Point of Entrance (Building Entrance) – The point within a building at which the OSP communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) connected by a grounding conductor to an electrode in accordance with the CEC.

D. RMC – Rigid Metal Conduit

E. UL – Underwriters Laboratory

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Division 26 0500:

1. Product Information

   a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.

   b. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.

2. Shop Drawings

   a. Provide scaled drawings (not less than 1/8” – 1’-0”) indicating routing of conduits and locations of all pull points (to include pull boxes, communications LB, etc.). These locations are to be fully coordinated with all other trades.

C. The following submittals are due Post-Construction, in accordance with submittal requirements in Division 26 0500:

1. Record Drawings

a. Provide scaled drawings (not less than 1/8" = 1'-0") indicating actual installed routing of conduits and locations of all pull points. Design or shop drawings modified in the field will not be accepted.

D. Keys for any pull boxes (if applicable)

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Electrical specifications for additional information.

2.02 CONDUIT

A. Refer to execution section for sizing and installation requirements.

B. Refer to Electrical specifications for list of approved manufacturers.

C. The minimum conduit trade size for telecommunications shall be 1 inch.

2.03 BACKBOXES

A. At minimum, the typical communications backbox shall be 4-11/16-inch square by 2-1/8- inch deep with 1-1/4-inch knockouts and a 4-11/16-inch Square Mud-Ring for one (1) device (single-gang) unless noted otherwise.

2.04 PULLBOXES

A. Material shall be aluminum or steel.

B. Manufacturer

1. Hoffman

2. Hubbel-Wiegmann

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor shall follow all manufacturers' instructions.

B. Coordinate with all other trades prior to installation.

3.02 CONDUIT

A. Conduit size to telecommunications outlets shall be minimum trade size 1 inch unless otherwise noted.

B. Conduits which enter Telecommunications Spaces shall extend:

1. 4-inches above finished floor

2. 3-inches below finished ceiling

3. 3-inches through wall

C. Conduits shall be reamed and bushed.

D. Telecommunications building entrance conduits shall be RMC construction.

E. Minimum Bend Radius

1. For trade size conduits 2-inches or less, maintain a minimum bend radius of six (6) times the actual inside diameter of the conduit.

2. For trade size conduits greater than 2-inches, maintain a minimum bend radius of ten (10) times the actual inside diameter of the conduit.

F. No continuous section of conduit may exceed 100-feet. Utilize pull boxes as necessary.

G. No continuous section of conduit may include more than two (2) 90 degree bends (or equivalent).

H. Install polyaramid pull tape in empty, spare conduits with size per Section 26 0534. Do not install pull rope in spare conduits.

I. Flexible Conduit

1. As defined by the CEC.

2. To be utilized only at specific locations identified on the drawings and previously approved by the Owner prior to installation.

3. Sections are to be limited to a maximum of 20-feet in length and the trade-size shall be increased by one. The minimum trade size shall be 1-1/2-inch unless otherwise noted and approved.

END OF SECTION

SECTION 27 0543 – UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This section shall govern the products and installation of all necessary parts, pieces and accessories of an underground duct and raceway system for communications cabling including manholes and handholes.

B. Underground Ducts and Raceways are used to interconnect spaces such as buildings, pedestals, cabinets, maintenance holes and handholes. All pathways shall be underground or direct buried. Aerial pathways shall be prohibited.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this section.

B. Section 26 0500 Common Work Results for Electrical, for material submittal requirements.

C. Division 02 – Existing Conditions

D. Section 27 0526 - Grounding and Bonding for Communications Systems

1.03 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Division 01:

1. Product Information: For the following:
    a. Pullbox and Hardware.
    b. Duct-bank materials, including spacers and miscellaneous components.
    c. Warning tape.
    d. Grounding and bonding.
2. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
3. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.

C. The following submittals are due Post-Construction, in accordance with the submittal requirements in Division 01:

1. Record Drawings
    a. Provide scaled drawings indicating routing of pathway and cable as well as locations of telecommunications spaces such as maintenance holes or handholes.
2. Manufacturer and Maintenance Manuals for all installed equipment.
    a. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.

b. List of bill of materials, including all parts, pieces and connectors required for installation of the underground duct and raceway including manholes and handholes.

3. Deliver to owner any special tools produced by the manufacturer required to install or uninstall any component of the system.

1.04 QUALITY ASSURANCE

A. Devices and Accessories (including conduits for communications): Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with ANSI C2.

C. Comply with CEC.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver conduits to Project site with ends capped. Store nonmetallic conduits with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.06 COORDINATION

A. Coordinate layout and installation of conduits and manholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of conduits and duct bank entrances into manholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure conduit runs drain to manholes and as approved by the Owner Representatives.

PART 2 - PRODUCTS

2.01 GENERAL

A. All Ducts/Raceway

1. The number, size, raceway duct material and arrangement shall be as indicated on Drawings and or as specified herein.

2. Use non-metallic Schedule 40 PVC (heavy wall), galvanized rigid conduit (GRC) or Smoothwall HDPE as indicated on Drawings and/or as specified herein.

3. Shall be capped with manufactured caps (duct plugs) when installation is temporarily discontinued or installed for future use.

4. Shall be 4-inch nominal trade size, unless otherwise noted or approved by the Owner.

5. Shall be checked by pulling a round wood or steel test mandrel, sized for each duct from both directions to remove obstructions.

6. Shall be cleaned by passing a wire brush mandrel and/or rubber duct swab (or approved alternative) of appropriate size back and forth until all foreign materials and water are removed.

7. Shall be encased by a concrete envelope when subject to vehicle traffic, minimum 3" cover on all sides.
8. Shall be installed using long radius sweeps to minimize pulling tensions, unless otherwise noted on Drawings or in specifications. No more than 180 degrees of total bends in any one section of conduit.
9. Shall be installed with minimum of 3-inches fall per 100-foot run toward manholes and away from buildings.
10. Each conduit shall have a polyaramid tape placed within the conduit and secured at each end. Refer to Specification Section 26 05 34 for size of tape. Tape shall be printed with sequential footage markings for accurate measurements.
11. Provide a minimum of 12" separation between electric power and telecommunications ducts.
12. A minimum of 30-inches bury depth (measured from top of duct or concrete encasement to finished grade) is required. Exceptions may be granted to avoid interferences with approval from the Owner.
13. The distance between telecommunications manholes or pullboxes shall be no greater than 500-feet.

2.02 CONDUIT

A. Non-Metallic Raceways

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Carlon
   b. Cantex
   c. Allied Tube and Conduit
   d. Approved Equal
2. Product: Shall be PVC Schedule 40 Conduit for application underground, encased or exposed applications in accordance with California Electrical Code.
3. Requirements
   a. Conduit shall be rated for use with 75°C conductors, UL Listed or approved equal. Material shall comply with NEMA Specification TC-2 (Conduit), TC-3 (Fittings) and UL 651 (Conduit) and 514b (Fittings).
   b. Conduit and fittings shall carry a UL label (Conduit – on each 10 foot length; Fittings – stamped or molded on each fitting).
   c. Conduit and fittings shall be identified for type and manufacturer and shall be traceable to location of plant and date manufactured. The marking shall be legible and permanent.
   d. The Conduit shall be made from polyvinyl chloride compound (recognized by UL) which includes inert modifiers to improve weatherability and heat distortion. Clean rework material, generated by the manufacturer's own conduit production, may be used by the same manufacturer, provided the end products meet the requirements of this specification.
   e. The conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth

and free of blisters, nicks or other imperfections which could mar conductors or cables.

f. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity

4. All underground conduits shall be at minimum, 4-inch nominal trade size, unless otherwise noted and approved by the Owner.

5. All bends shall be factory made and be at least ten (10) times the diameter of the conduit.

6. Provide bushings on all conduit terminations.

7. Splice conduits with fittings approved by the conduit manufacturer for the specified applications.

2.03 TEXTILE/FABRIC INNERDUCT

A. Manufacturer shall be MaxCell Group/TVC Communications

1. Substitutions will not be acceptable.

B. Detectable Outdoor Textile Innerduct: 2-inch, 3-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape, and a solid copper, polyvinyl color coated conductor (19AWG minimum) for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the textile sleeve.

2.04 TEXTILE/FABRIC INNERDUCT FITTINGS

A. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.:

1. 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration

B. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.

2.05 COMMUNICATIONS PULLBOXES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Armorcast

2. Oldcastle Precast

3. Jensen Precast

B. Description

1. The lid (cover) for all pullboxes shall be traffic-rated. Specific rating of pullbox shall be listed on Drawings of pullbox details. Lid shall be lettered “Communications”.

2. Telecommunications pullboxes shall not be shared with electrical installations other than those needed for telecommunications equipment.

3. Conduits shall enter and exit the pullbox in a straight line method. The remaining parallel shall remain free of conduit entrances to allow cable support and splicing operations.

4. Provide signage within pullboxes: to include manhole/handhole designator, measured distance to the next manhole/handhole, access point or building, North designation and direction to adjoining maintenance holes and building entrance points.

5. Cover Finish: Nonskid finish.

2.06 ACCESSORIES

A. Grounding Materials: Comply with Section 26 0526.

B. Conduit-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg. F. Capable of withstanding temperatures of 300 deg. F without slump and of adhering to clean surfaces of plastic conduits, metallic conduits, conduit coatings, concrete, masonry, lead cable sheaths, cable jackets, insulation materials, and common metals.

C. Conduit Duct Plugs:

1. Duct plugs shall be manufactured from high impact plastic components and shall be corrosion proof.

2. Duct plugs shall contain a durable elastic compressible gasket which will make it effective as long term or temporary seal. They shall be removable and reusable.

3. They shall meet or exceed the following mechanical requirements:

a. Air Pressure: 7.5 psi

b. Water Head: 15 ft.

c. Pull Out: 100 Kgf.

PART 3 - EXECUTION

3.01 GENERAL

A. All bends shall be manufactured factory long, sweeping bends, at least ten times the internal diameter of conduits larger than 4-inches.

B. In underground raceways, angle couplings and bends alone or in combination with straight sections shall be used for direction changes. Direction changes made by skewing straight sections of conduits will not be permitted. Direction changes made in manholes or handholes will not be permitted.

C. Conduits shall be Schedule 40 PVC.

D. Conduits shall be capped with manufactured caps (duct plugs) when installation is temporarily discontinued.

E. Conduits shall be cleaned by passing a wire brush mandrel and/or rubber duct swab of appropriate size back and forth until all foreign materials and water are removed.

F. Conduits shall be checked by pulling a round test mandrel, 1/4-inch less than the conduit's size for each duct from both directions to remove obstructions.

G. No section of conduit shall have more than 180° of bends without a manhole or handhole installed for an access point.

H. No conduit run shall extend more than 500 feet without a manhole or handhole installed as an access point.

I. Conduit connections from buildings to manholes shall be installed with a minimum of 3 inch fall per 100 feet of conduit towards the manhole and sloping away from the building

J. Conduits shall be inspected and approved for correct formations and tied to prevent ducts from floating when concrete is poured.

K. A minimum of 30 inches bury depth (measured from top of conduit or concrete encasement to finished grade) is required.

L. Install a 6" orange warning tape labeled fiber optics above all conduits. Install tape 12 inches above the entire conduit or duct bank.

M. Requirements for Non-metallic Raceways

1. Install for all raceways except where rigid conduit is required.
2. Install only manufacturer approved system components and methods.
3. Typical nonmetallic conduits installation consists of a minimum of PVC Type Schedule 40.
4. Provide minimum of 30 inches bury depth measured from the top conduit to finished grade.
5. Bond PVC duct with couplings using manufacturer approved adhesives.
6. Install metallic threaded adapter when attached to rigid conduit.
7. Protect from deformation during stockpiling. Maintain circular shape. Other configurations will not be permitted.
8. Comply with the manufacturers requirements for bending and cutting.
9. All joints shall be wrapped with 1.5" or larger Scotch #88 tape as temporary concrete seal.
10. Provide with end bells flush with inside wall of manhole or vault.
11. Cover with select compactable soil, free of stones and debris.

3.02 CONDUIT INSTALLATION

A. Slope: Pitch conduits a minimum of 3-inches fall per 100-foot run down toward manholes, handholes and away from buildings and equipment. Slope conduits from high point in runs between two manholes to drain in both directions.

B. Use solvent-cement joints in conduits and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent conduits do not lie in the same plane.

C. Building Entrances: Make a transition from underground PVC to rigid galvanized steel conduit 5-feet from exterior wall of the building. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-Encased Conduit: Install reinforcement in conduit banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Waterproofed Wall and Floor Penetrations: Install a watertight entrance sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

D. Concrete-Encased, Nonmetallic conduits: Support conduits on spacers, spaced as recommended by manufacturer and coordinated with conduit size, conduit spacing, and outdoor temperature. Install as follows:

1. Excavate trench bottom to provide firm and uniform support for conduit.

2. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrance through floor.

   a. Couple steel conduits to duct with adapters designed for this purpose, and encase coupling with 3-inches of concrete for a minimum of 12 inches on each side of the coupling.

   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60-inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

3. Underground Warning Tape: Bury detectable warning tape labeled “FIBER OPTIC” OR “TELECOMMUNICATIONS” 12-inches to 18-inches above direct buried conduits, but at minimum of 6-inches below grade. Align warning tape along centerline of conduit.

4. Separator installation: Space separators close enough to prevent sagging and deforming of conduits and secure separators to earth and to conduits to prevent floating during backfilling. Stagger spacers approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around conduits or conduit groups.

5. Concreting: Space concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto conduits. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelop between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plan and install 3/4-inch reinforcing rod dowels extending 18-inches into concrete on both sides of joint near corners of envelope.

6. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated on Drawings.

7. Forms: use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise use forms.

8. Minimum Clearances between Conduits: 3-inches between conduits and exterior envelope wall, 3-inches between conduits for like services, and 4-inches between power and signal conduits.

9. Depth: Install top of duct bank at least 30-inches below finished grade in non-traffic areas and at least 36-inches below finished grade in vehicular traffic areas, unless otherwise indicated. If depth cannot be met, contact the Owner for variance before proceeding.

E. Non-Metallic Conduits – No Encasement - Support conduits on spacers, spaced as recommended by manufacturer and coordinated with conduit size, conduit spacing, and outdoor temperature. Install as follows:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 26 0543 “Underground Ducts and Raceways for Electrical Systems” for conduit less than 6-inches in nominal diameter.

2. Install backfill as specified in Section 26 0543 “Underground Ducts and Raceways for Electrical Systems”

3. Backfilling: Spade backfill carefully to prevent voids under and between conduits and exterior surface of envelope. Do not allow a heavy mass of backfill to fall directly onto conduits.

4. After installing conduit, backfill and compact. Start at the tie-in point and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12-inches of finished grade make final conduit connect at end of run and complete backfilling with normal compaction as specified in Section 26 0543 "Underground Ducts and Raceways for Electrical Systems"

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrance through floor.

    a. Couple steel conduits to duct with adapters designed for this purpose, and encase coupling with 3-inchs of concrete for a minimum of 12 inches on each side of the coupling.

    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60-inches from edge of foundation or equipment base. Install insulated grounding bushing son terminations at equipment.

6. Underground Warning Tape: Bury detectable warning tape labeled "FIBER OPTIC" OR "TELECOMMUNICATIONS" 12-inches to 18-inches above direct buried conduits, but a minimum of 6-inches below grade. Align warning tape along centerline of conduit.

7. Separator installation: Space separators close enough to prevent sagging and deforming of conduits and secure separators to earth and to conduits to prevent floating during backfilling. Stagger spacers approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around conduits or conduit groups.

8. Backfilling: Spade backfill carefully to prevent voids under and between conduits and exterior surface of envelope. Do not allow a heavy mass of backfill to fall directly onto conduits.

9. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.

10. Forms: use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise use forms.

11. Minimum Clearances between Conduits: 3-inches between conduits and exterior envelope wall, 3-inches between conduits for like services, and 4-inches between power and signal conduits.

12. Depth: Install top of duct bank at least 30-inches below finished grade in non-traffic areas and at least 36-inches below finished grade in vehicular traffic areas, unless otherwise indicated. If depth cannot be met, contact Engineer and Owner for variance before proceeding.

F. Sealing: Provide temporary closure at terminations of conduits and innerducts that have cables pulled. Seal spare conduits and innerducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

3.03 TEXTILE INNERDUCT INSTALLATION

A. Provide textile innerduct in conduit and wire ways, and place textile innerduct within and under cable trays using continuous unspliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.

B. Make a 2" incision, approximately 18" from the end of textile innerduct. Pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells.

C. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over all knots and the end of textile innerduct. Using a Bow Line knot tie a SWIVEL to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each textile innerduct.

D. Attach the pull tape located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.

E. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.

F. Textile Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.

1. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
2. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires
3. When appropriate, use the following cable ties to secure textile innerduct through previously created incisions:
    a. Plenum areas: plenum-rated plastic or stainless steel
    b. Non plenum areas: Conventional flame-retardant nylon ties
    c. Underground locations : Conventional plastic cable ties

G. Maintenance Hole and Hand Hole Installation:

1. At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.
2. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.

H. Penetrations

1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents.
2. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.
3. Raceway Penetrations: After textile innerduct installation, install intumescent fire barrier penetration sealing material (Hilti system) between textile innerduct and conduit or wire way at all exposed penetration locations.
4. Inflation bags for MaxCell 4” Plug kit shall be used to seal conduits in maintenance holes or handholes.
5. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.

6. Document entire installation process for future referral.

3.04 UNDERGROUND HANDHOLE AND PULLBOX INSTALLATION

A. Install handholes and pullboxes level and plumb with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1-inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate clearance in enclosure.

E. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 CONCRETE ENCASEMENT

A. Provide as shown on drawing and in accordance with these specifications. Duct banks shall not receive less than 3 inches of concrete cover all around and 1-1/2-inches between raceways.

B. Rebar reinforcement is required where duct banks will cross roadways, railways or similar heavily traffic areas.

C. Protect against rain, flooding, freezing, etc., during curing.

D. Ensure no honeycombing occurs and be properly vibrated with small vibrator. Do not vibrate between ducts.

E. Concrete for the duct bank shall be placed in such a way that the duct bank will not be disturbed and that the sides of the trench do not crumble, using splash boards, proper placement, etc. The vertical drop of concrete from chute shall not exceed 30-inches.

F. Concrete shall be poured continuous from manhole to manhole. No pours shall originate between manholes.

G. Interval between base or intermediate spacers shall not exceed 8 feet with a minimum of two supports per length of duct.

H. Make provisions, such as nylon ties, to prevent the ducts from floating when concrete is poured.

3.06 BACKFILL

A. Per Division 26 0543 Underground Ducts and Raceways for Electrical Systems.

3.07 EXCAVATION

A. Coordinate excavation with other trades, disciplines, specifications and drawing before starting work.

B. Verify all elevations and arrangements are correct and there are no conflicts with other utilities. Verify that the entryways into manholes, buildings and other structures meet Owner Standards. It will be the responsibility of the Contractor and Design Team to ensure Owner

requirements are met. All corrections needed to meet Owner Standards are the responsibility of the Contractor.

C. Verify all utilities have been located. Contractor shall contact Dig Alert to request a utility locate prior to beginning any excavation work, for onsite assistance in locating known underground utilities in the area of work. Complete all requirements of Dig Alert before excavating. Report any conflicts or omitted utility locates to the Owner.

D. If soil conditions are such that because of the depth or any other reasons the trench/excavation cannot conform to the size of the duct bank, provide forms and bracing as required.

E. Contractor shall open entire length of trench and establish proper grades before beginning installation of any portion of connecting duct runs.

F. Coordinate and comply with related sections of the project specifications for Excavation, Backfill, Concrete, Asphalt Repairs and Related Work.

G. Depth of excavation shall be such that the required bury depths (top of concrete encasement) are met. Prior to installation Owner shall approve any deviation from required depths. It is the responsibility of the contractor to call for Owner inspection before closing any work.

3.08 REINFORCING:

A. Reinforcing shall be installed when the following conditions are present and as specified in the project documents and References listed with this section.

1. Where noted on drawings and /or as specified herein.
2. Where crossing trenches for other work.
3. At conduit joints.
4. If continuous pour is impractical, provide (4) #4 reinforcing bars extending 6 feet into first and second pour.
5. Where trenches cross roadways and railways.
6. Reinforcing shall be supported from bottom of trench at least one inch and is not required if conduits are supported by saddles.

3.09 BACKFILL

A. Contractor shall contact Owner prior to backfilling any underground utility lines and shall allow adequate time during normal business hours for Owner personnel to survey and establish location and depths of all lines.

B. Shall not be installed until after concrete has reached initial set.

C. Meet all requirements of Division 1 and 2 specifications for excavation, backfill, compaction, and restoration.

D. The Contractor shall restore landscape to its original condition or as specified by the project documents.

3.10 WARRANTY & AS-BUILTS

A. The Contractor shall provide a 1 year warranty on materials and labor for all work associated with duct banks, manholes, handholes, associated apparatus and all other infrastructure components associated with this section. Warranty period shall commence at the time of project acceptance by Owner.

B. The Contractor shall provide as-built drawings and documentation to the Owner prior to final payment for this work.

END OF SECTION

SECTION 27 0553 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this section.

B. Section 26 0500 Common Work Results for Electrical, for material submittal requirements.

1.02 SECTION INCLUDES

A. Cabling identification products.

PART 2 - PRODUCTS

2.01 IDENTIFICATION PRODUCTS

A. Submit catalog cutsheets of proposed materials to be used for Owner approval. Submit material cutsheets in accordance with Division 01 and Section 26 0500.

B. Comply with TIA-606-A and UL969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during normal maintenance of the infrastructure.

D. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.

E. The text on labels shall be machine generated.

PART 3 - EXECUTION

3.01 IDENTIFICATION

A. Labels for system components, wiring, and cabling shall comply with TIA-606-A for Class 4 level of administration.

B. Cable Schedule: Install in a prominent location in communication rack. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover.

C. Cable and Wire Identification

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with a name and number of particular device as shown.

D. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA-606-A, for the following:

1. Labeling for cables shall use flexible vinyl or polyester that flexes as cables are bent.

E. The alphabetical letters “I”, “O”, and “Q” shall be excluded from use in all labels.

3.02 INTER-BUILDING CABLE

A. A unique identifier shall be assigned to each inter-building cable segment.

1. The inter-building identifier shall be coordinated with the Owner.

2. The inter-building identifier shall have the format:

a. Provided by the Owner.

b. Cable identifiers shall correspond to test reports

3. Cables shall be labeled on both ends and at within 12-inches of each entrance and exit of a maintenance hole, handhole, or splice case.

4. Cable labeling shall be accomplished via machine printed labels. Text on labels should be a font without serifs, upper case and large enough to be easily read. Labels shall be durably affixed to both ends of each cable conspicuously displayed prior to each cable being routed into the terminate device and within 12-inches of the end of the cable jacket.

3.03 GROUNDING AND BONDING LABELING

A. TMGB Identifier

1. The TMGB identifier is used to identify the single TMGB present in a building.

B. BCT Identifier

1. The BCT identifier is used to identify the BCT in the telecommunications bonding and grounding system. This identifier shall be unique.

2. Label the BCT and each telecommunications backbone conductor at its attachment point on each end of the conductor: “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”

3. Each BCT shall be labeled with its identifier on both ends. The labels shall be durably affixed to both ends conspicuously displayed just prior to the conductor being routed into its termination.

END OF SECTION

SECTION 27 1323 – COMMUNICATIONS OPTICAL FIBER CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Inter-building Fiber Optic Cable

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 26 0500 Common Work Results for Electrical, for material submittal requirements.

C. Section 27 0500 – Common Work Results for Communications

1.03 APPLICABLE PUBLICATIONS

A. As defined in Section 27 0500 – Common Work Results for Communications

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. The Contractor shall submit the following materials to the Owner prior to the placement of cable:

1. Product data, including both product construction and performance specifications, for each type and configuration of cable and termination to be supplied.

2. Copies of signed optical cable reel tests.

3. Proof of Broadband Communications Engineer and Technician qualifications.

4. Proof of required licenses.

PART 2 - MATERIALS

2.01 The products listed in this section represent the standards for materials, workmanship, and performance for this project.

2.02 FIBER OPTIC CABLE (MULTIMODE)

A. Materials

1. Application: Use for placement within the 12kV switchgear building.

2. Compliance: Meet or exceed ANSI/EIA/TIA-492 AAAA specifications and characteristics listed below.

3. Characteristics:

a. Multimode 62.5µm Dielectric Sheath Outside Plant Cable – 10Gb/s – Supporting 300 meter channel –Loose Tube

b. The loose tube dielectric OSP cable shall be constructed with industry standard 3mm buffer tubes, stranded around a central strength member.

c. The buffer tubes shall compatible with standard hardware, cable routing and fan-out kits.

d. The cable core shall be water blocked with dry water-blocking materials, making access and handling of individual tubes easier and craft-friendly.

e. The cables shall be designed for point-to point applications as well as mid-span access, and provide a high-level of protection for fiber installed in the outside plant environment. The cable should be approved for installation in underground ducts or wet environments.

f. The cables shall meet the following specifications:

Core Diameter	62.5 (±3.0)µm as specified on Drawings
Core Non-Circularity	<=5%
Cladding Diameter	125 (±2)µm
Core/Cladding Concentricity Error	<=3.0µm
Cladding Non-Circularity	<=2.0%
Coated Fiber Diameter (uncolored)	245 (±5)µm
Coating/Cladding Concentricity Error	<=12µm
Colored Fiber Diameter	254 (±7)µm
Proof Test Levels	100 kpsi minimum
Dynamic Fatigue Parameter	>=20
Macrobending (100 turns on a 75 mm mandrel)	<=0.5dB @ 850 nm and 1300 nm
Operating Temperature	-60 to 85°C
Numerical Aperture	0.275 ± 0.015
Effective Group Index of Refraction @ 850 nm	1.496
Effective Group Index of Refraction @ 1300 nm	1.491
Point Discontinuities @ 850 nm or 1300 nm	<= 0.2 dB
Maximum Cable Loss	3.7 dB/km @ 850 nm 0.7 dB/km @ 1300 nm
Minimum Bandwidth	160/200 MHz-km @ 850 nm 500 MHz-km @ 1300 nm
Zero Dispersion Wavelength	minimum 1332 nm maximum 1354 nm
Zero Dispersion Slope	<=0.097 ps/(nm^2 km)

Cable Identification:

Buffer Tubes and Fibers are identified with standard color coding:		
1 - Blue	5 - Slate	9 - Yellow
2 - Orange	6 - White	10 - Violet
3 - Green	7 - Red	11 - Rose
4 - Brown	8 - Black	12 - Aqua

Buffer tubes 13 through 24 repeat the color sequence with tracer stripe:e.g.fiber 13 is blue with tracer strip

g. The cable shall support current and next-generation LAN, SAN, and WAN applications via laser-optimized 62.5/125-µm optical fibers.

h. The cable shall extend the distance of low-cost 850-nm VCSEL-based electronics, supporting 1100 m at 1 Gb/s and 550 m at 10 Gb/s.

i. The Loose Tube Dielectric cable shall be constructed with industry standard 3mm buffer tubes, stranded around a central strength member.

j. The buffer tubes shall be compatible with standard hardware, cable routing and fan-out kits.

k. The cable core shall be water blocked with dry waterblocking materials, making access and handling of individual tubes easier and craft-friendly.

B. Manufacturer:

1. SYSTIMAX

2. Corning

3. Superior Essex
4. or Approved Equal

2.03 FIBER OPTIC CABLE (SINGLE-MODE)

A. Materials

1. Application: Use for placement in outside plant conduit between buildings.
2. Compliance: Meet or exceed ANSI/EIA/TIA-492 CAAA specifications and characteristics listed below.
3. The cables shall meet the following specifications:

Core Diameter	8.2µm or as specified on Drawings
Core Non-Circularity	<=0.7%
Cladding Diameter	125 (±0.7)µm
Core/Cladding Concentricity Error	<=0.5µm
Cladding Non-Circularity	<=1.0%
Coated Fiber Diameter (uncolored)	245 (±5)µm
Coating/Cladding Concentricity Error	<=12µm
Colored Fiber Diameter	254 (±7)µm
Proof Test Levels	100 kpsi minimum
Dynamic Fatigue Parameter	>=18
Macrobending (100 turns on a 75 mm mandrel)	<=0.05dB @ 850 nm and 1300 nm
Operating Temperature	-60 to 85°C
Numerical Aperture	0.14
Effective Group Index of Refraction @ 1310 nm	1.4674
Effective Group Index of Refraction @ 1550 nm	1.4679
Point Discontinuities @ 850 nm or 1300 nm	<= 0.05 dB
Maximum Cable Loss	<= 0.35 dB/km @ 1310 nm <= 0.23 dB/km @ 1625 nm
Zero Dispersion Wavelength	minimum 1304 nm maximum 1324 nm
Zero Dispersion Slope	<=0.092 ps/(nm^2 km)

2.04 FIBER OPTIC TERMINATIONS

A. Use LC connections for fiber optic cable terminations, compatible with type of fiber installed. Terminate cables in patch panels, in locations approved by Owner.

2.05 FIBER OPTIC PATCH PANELS

A. Manufacturer:

1. SYSTIMAX
2. Belden
3. Or Approved Equal

B. Shall be wall-mountable; and accommodate up to 48 ports with LC-style connectors.

1. SYSTIMAX WBE-EMT-BK-4P-MOD enclosure or equal, with Modular Cassettes for fiber terminations.
2. Cartridges installed in enclosure shall be compatible with LC terminations, SYSTIMAX 12-LC-SM-BL or equal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. All installation work shall be performed according to published industry guidelines, rules, and regulations. If disputes occur, local, state, and national codes have precedence; then Owner policies and procedures; then standards such as EIA/TIA; then guidelines from firms such as Building Industry Consulting Services International (BICSI), AT&T, Systimax Solutions Inc., and then finally, manufacturer recommendations.

B. The Contractor shall provide sufficient trained staff to monitor all work undertaken and to ensure that the requirements of these specifications are met throughout the installation process.

C. All installation work will be of the highest quality. The Contractor shall at all times make every effort to conduct all installation work in a manner so as to minimize the impact on the communications infrastructure.

D. The Contractor shall provide and install all pathway and cable support hardware necessary to successfully complete the installation. This includes, but is not limited to, hangers, ladder racks, support brackets, conduit and sleeves, firestop materials, tie-wraps, and access openings such as core drills.

E. The Contractor shall ensure that only staff fully qualified to work on specific types of materials are allowed to undertake the required installation. Particularly, fiber optic cable placement, termination, splicing, and testing shall only be undertaken by staff who are certified by the manufacturer of the installed components.

F. The Contractor shall provide all hardware, software, and miscellaneous components necessary to provide a complete system.

G. The Contractor shall coordinate cutover schedules with the Owner prior to installation. The work will be scheduled so that the voice and data networks will be out of service for a minimum period of time

H. No cables will be spliced without written authorization from the Owner.

I. The bend radius of any cable installed must not exceed the manufactures specifications. In those cases, such as in wire mold, where the minimum radius cannot be maintained, a 90 degree fitting is to be used provided the performance criteria are not jeopardized.

3.02 INTER-BUILDING FIBER OPTIC CABLE

A. All fiber cable will be pre-tested by the manufacturer, before shipping, to guarantee there are no defective fibers. These cables should be re-tested, on the reels, before installation to ensure no damage occurred during shipping.

B. No splices shall be made in the fiber optic cable plant except where noted on construction prints. Any splice must be approved in advance by the Owner. Any splices allowed must be fusion splices, and the splice loss must not exceed .2dB at 1300 nm.

C. All splices must be fusion splices, any pigtails used must be tight buffered Kevlar, and splice loss must not exceed .2dB at 1300 nm.

D. All fiber optic cable must be coiled and securely mounted to the wall in a manner that will prevent physical damage.

E. All cables (and panels) must be clearly identified. Labels will be securely attached to the cable at each end whenever it enters or leaves a conduit, and at 30 foot intervals when run in accessible areas such as tunnels, manholes, ceilings, etc. with the Owner

approved cable/optic numbering system. Cable identification number must match that listed in cable test report.

F. All fiber optic cables installed within a tunnel shall be placed in innerduct, which is secured every six feet or is placed within the cable tray. All fiber optic cable installed in conduit (not sleeves) shall also be in innerduct.

G. Direct termination of the multimode fiber optic cables with “LC” terminations is required. Each fiber type must have the appropriate “LC” connector. The terminating patch panels must provide adequate enclosed splice trays to secure the splices.

H. The Contractor shall ensure proper placement and pulling techniques are employed throughout the installation and testing of this cable. Breakaway swivel grips shall be used to reduce coiling of cable during the pull and to limit the potential of exceeding the stated pulling tension. Any observed bending of any fiber cable during and after the installation that exceeds the manufacturer’s recommended bending radius shall be cause for complete replacement of that cable by the Contractor.

I. Inter-building fiber optic cable shall be placed within a MaxCell innerduct unless otherwise noted.

J. All fiber must be terminated in their respective patch panel. Field termination kits and pigtails, if utilized, shall be properly secured and protected from mechanical damage.

K. Coils of slack cable shall be provided in each fiber termination unit (patch panel) prior to terminating the cable on connectors. The amount of cable should comply with the manufacturer’s requirements that are specified for the fiber termination unit.

L. At least 5 meters of cable (maintenance loop) neatly coiled and secured to the wall is required at each end of the fiber optic run.

3.03 TESTING

A. All fiber optic cables shall be tested in accordance with Section 26 0800.

END OF SECTION

SECTION 27 1500 – COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Copper Station Cable

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 26 05 00 Common Work Results for Electrical, for material submittal requirements.

C. Section 27 0500 – Common Work Results for Communications

1.03 APPLICABLE PUBLICATIONS

A. As defined in Section 27 0500 – Common Work Results for Communications

1.04 SUBMITTALS

A. Comply with Section 26 0500 for additional submittal requirements and procedures.

B. The Contractor shall submit the following materials to the Owner prior to the placement of cable:

C. Product data, including both product construction and performance specifications, for each type and configuration of cable to be supplied. In addition, the Contractor shall provide product data and installation instructions for all fire-stop materials.

D. Copies of signed optical cable reel tests.

E. Proof of Broadband Communications Engineer and Technician qualifications.

F. Proof of required licenses.

PART 2 - PRODUCT

2.01 COPPER HORIZONTAL (STATION) CABLE

A. Material

1. Use for data applications to interconnect services from devices or outlets to the substation telecommunications enclosure in a non-plenum rated space.

2. Four pair, 24 AWG, Category 6, UTP, as defined by the EIA/TIA standards intended for use with transmission rates up to and including 1 Gbps.

3. A different colored Category 6 cable is to be used consistently throughout the project for each different colored jack. Data1 is to use yellow cable with a orange jack. Data2 is to use blue cable with a blue jack. Data3 is to use white cable with a white jack.

4. The high-performance Category 6 UTP cable shall be of the traditional round design with Mylar bisector tape.

5. The cable shall support Voice, Analog Baseband Video/Audio, Fax, Modem, Switched-56, T-1, ISDN,RS-232, RS422, RS-485, 10BASE – T Ethernet, Token Ring, 100Mbps TP-PMD, 100BASE-T Ethernet.

6. The cable jacket shall comply with Article 800 CEC for use as a non-plenum cable. The 4 pair UTP cable shall be UL Listed Type CM (non-plenum).

7. Performance shall be characterized to 550 MHz to support high-bandwidth video applications

8. All Category 6 high performance cables shall the following specification:

	Non Plenum
Weight	25.3 lb (1000 ft)
Jacket Thickness	.022 in
Outside Diameter	0.232 in
Conductor Diameter	.022 in
Insulation Type	High density Polyethylene
Jacket Material	PVC
Maximum Pulling Tension	25 lbs
Nom. Velocity of Propagation	0.69
Max DC Resistance	9.83 Ohms/100m
Mutual Capacitance @ 1kHz	4.95 nF/100m
Operating Temperature	-20 to 60° C
UL Type	CMR & CMG

9. The high-performance Category 6 cable shall be specified to 550 MHz and shall meet the guaranteed swept margin as follows:

	High Performance Cable	High Performance Channel (4 Connections)	Premium Performance Channel (4 Connections)
	Typical Worst Pair Margin*	Guaranteed Margin**	Guaranteed Margin**
Insertion Loss	3.0 %	5.0%	7.5%
NEXT	6.0 dB	6.0 dB	7.0 dB
PSNEXT	6.0 dB	7.5 dB	8.5 dB
ELFEXT	5.0 dB	6.0 dB	8.0 dB
PSELFEXT	5.0 dB	8.0 dB	10.0 dB
Return Loss	4.0 dB	4.0 dB	4.0 dB
Frequency Range	1-550 MHz	1-250 MHz	1-250 MHz

*Typical worst pair swept margin.
**Guaranteed margin is valid at any frequency from 1-250 MHz for the single manufacturer's certified channel comprising the single manufacturer's Category 6 apparatus and the single manufacturer's High-Performance series cable. Values represent margin over the TIA/EIA Category 6/Class E channel specifications.

B. Manufacturer

1. SYSTIMAX

2. Panduit

3. or Approved Equal

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. All installation work shall be performed according to published industry guidelines, rules, and regulations. If disputes occur, local, state, and national codes have precedence; then Owner policies and procedures; then standards such as EIA/TIA; then guidelines from firms such as Building Industry Consulting Services International (BICSI), AT&T, Systimax Solutions Inc., and then finally, manufacturer recommendations.

B. The Contractor shall provide sufficient trained staff to monitor all work undertaken and to ensure that the requirements of these specifications are met throughout the installation process.

C. All tests will be conducted using equipment that has laboratory or manufacturer certified calibration within one year of the tests. The Contractor shall provide a signed copy of the calibration test results for each item of test equipment with the acceptance documentation.

D. All installation work will be of the highest quality. The Contractor shall at all times make every effort to conduct all installation work in a manner so as to minimize the impact on the facilities. Whenever possible, all work will be hidden behind finished materials and all surfaces will be returned to their original condition.

E. The Contractor shall provide and install all pathway and cable support hardware necessary to successfully complete the installation. This includes, but is not limited to, hangers, ladder racks, support brackets, conduit and sleeves, firestop materials, tie-wraps, and access openings such as core drills.

F. The Contractor shall ensure that only staff fully qualified to work on specific types of materials are allowed to undertake the required installation.

G. The Contractor shall provide all hardware, software, and miscellaneous components necessary to provide a complete system.

H. The Contractor shall coordinate cutover schedules with the Owner prior to installation. The work will be scheduled so that the voice and data networks will be out of service for a minimum period of time

I. No cables will be spliced without written authorization from the Owner.

J. The bend radius of any cable installed must not exceed the manufactures specifications. In those cases, such as in wire mold, where the minimum radius cannot be maintained, a 90-degree fitting is to be used provided the performance criteria are not jeopardized.

3.02 COPPER HORIZONTAL (STATION) CABLE

A. All horizontal (station) cables shall be neatly dressed, secured, and concealed throughout the installation. Cables shall be secured using only hook and loop style fastening devices, and should be applied loosely to cable bundles so as to allow the sliding of the cable fastener across the cable bundle. Cable fasteners shall not deform the cable geometry. Cable fasteners shall be of a plenum-rated material if cable is installed within a plenum ceiling space.

B. Ceiling grid supports, electrical conduit, water pipes, and HVAC ducting may not be used to support cables. In those areas without adequate support structures, the Contractor shall install “J” hooks or additional ceiling grid hangers on five-foot centers. No more than 12 individual cables will be secured to a single ceiling hanger without the use of a two-inch wide saddle to eliminate strain on individual cables. Cables shall not be placed within 24 inches of overhead lights or any other potential source of electrical interference.

C. In any area in which a fire rated wall, partition, floor, or ceiling is penetrated, the Contractor shall be responsible for creating the pathway and sealing around all cables and sleeves with a UL classified fire seal sufficient to return the structure to its original rating. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the Contractor. Any opening in a rated structure created by the Contractor that is larger than one inch in diameter shall be equipped with a metal sleeve secured and fire-stopped in place.

D. In horizontal (station) locations with walls that must be fished, the Contractor shall place a plaster wall retaining ring or metal supporting “ears” around the outlet location to secure the outlet and face plate. No exposed cable shall be permitted.

E. In locations where the wall will not be fished and surface-mount raceways are utilized, all raceways must be mechanically secured to the structure a minimum of every four feet, must be routed at right angles to nearby structures or wall corners, and shall be neatly installed and trimmed to fit into and around other existing moldings or pathways such as the ceiling area.

F. A sufficient maintenance loop (slack cable), neatly coiled and secured in the ceiling space above the terminals, shall be placed for all horizontal (station) cables to allow for future rearrangement.

G. Voice and data station cables shall be terminated on insulated displacement hardware and shall be clearly marked with a unique identification number following the Owner standard.

3.03 FIBER OPTIC HORIZONTAL (STATION) CABLE

A. All fiber cable will be pre-tested by the manufacturer, before shipping, to guarantee there are no defective fibers. These cables should be re-tested, on the reels, before installation to assure no damage occurred during shipping.

B. No splices shall be made in the installed fiber optic horizontal (station) cable.

C. All fiber optic cable must be coiled and secured in a manner that will prevent physical damage.

D. All cables and panels must be clearly identified at both ends with a unique cable/optic numbering system as defined by the Owner.

E. All cables shall be installed and terminated using manufacturers. standard procedures, tools, and equipment and must be protected from physical damage. All fiber cables must be installed to protect the optical fibers and connectors from strain and physical damage. The minimum bending radius must not be exceeded during cable placement.

F. All cables and panels must be clearly identified at both ends with the Owner approved, cable/optic numbering system.

END OF SECTION

SECTION 31 01 90

LANDSCAPE AND SITE MAINTENANCE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Landscape maintenance and related work as shown on the Drawings and specified herein including, but not necessarily limited to, the following:
   1. Tree, shrub, ground cover and turf areas.
   2. Irrigation systems.
   3. General site clean-up.

B. Related Requirements:
   1. Section 32 80 00 - Irrigation
   2. Section 32 90 00 - Planting

1.02 REFERENCES AND REGULATORY REQUIREMENTS

A. State of California, Business and Transportation Agency, Department of Transportation (Caltrans) "Standard Specifications."

1.03 ADMINISTRATIVE REQUIREMENTS

A. Submittal Procedures: Action Submittals shall be submitted in accordance with Section 01 33 00 - Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data: Manufacturer's product information on pesticides and herbicides to be used for approval prior to use.

1.05 QUALITY ASSURANCE

A. Control of Work: Comply with Section 5 of the Standard Specifications.

B. Control of Materials: Comply with Section 6 of the Standard Specifications.

C. The Maintenance Contractor shall be experienced in horticulture and landscape maintenance, practices, and techniques, and shall provide sufficient number of workers with adequate equipment to perform the work during the Landscape Maintenance Period.

1.06 LANDSCAPE MAINTENANCE PERIOD

A. Landscape Maintenance Period shall be 60 calendar days.

B. Continuously maintain the entire project area during the progress of the work, during the specified Landscape Maintenance Period or until Final Acceptance of the project by the Owner's Representative.

C. Landscape Maintenance Period shall not start until all elements of construction, planting and irrigation for the entire project are completed in accordance with Contract Documents. A prime requirement is that turf and landscape areas shall be planted and that turf areas shall show an even, healthy stand of "sod-like" turf which shall have been mown twice. If such criteria are met to the satisfaction of the Owner's Representative, a written notification shall be issued to establish the effective beginning date of

Landscape Maintenance Period. Additionally, elements included in the Pre-maintenance Punch-list shall have been completed to the satisfaction of the Owner's Representative. The Landscape Maintenance period shall, at the discretion of the Owner's Representative, be allowed to start and finish at different times in different areas as applicable.

D. A day of improper maintenance, as determined by the Owner's Representative, shall not be credited as an acceptable Landscape Maintenance Period day. The Landscape Maintenance Period shall be extended on a day-for-day basis should this occur until proper maintenance, as determined by the Owner's Representative, is being performed.

E. Contractor shall secure the project site against trespass, vandalism, and theft during the Landscape Maintenance Period. Security procedures shall be coordinated with the Owner's Representative.

1.07 GUARANTEE

A. All work executed under this section shall be guaranteed against any and all poor, inadequate or inferior materials and/or workmanship, as determined by the Owner's Representative, for the entire Landscape Maintenance Period and for a period of one year after Final Acceptance of project.

B. The Contractor shall install all replacement material in conformance with the Contract Documents.

1.08 FINAL ACCEPTANCE

A. Upon completion of all project work, including Landscape Maintenance Period, the Owner's Representative will, upon written request from the Contractor (2 working day minimum notice), make an observation to determine conformance with the Contract Documents.

B. If, at the final project observation, work is found at variance with the Contract Documents, or is otherwise unacceptable, the Owner's Representative shall issue a punch-list of items requiring attention to the Contractor. The Contractor shall repair, replace, or otherwise correct all non-compliant work, continue Landscape Maintenance Period, and make another written request to the Owner's Representative to verify punch-list completion. If punch-list is found to be incomplete, or if site is still found to be unacceptable, the Contractor shall be back-charged as necessary for this and all additional observations required to issue Final Acceptance. All replacement materials and installations shall be in accordance with the Contract Documents. Remove rejected work and materials immediately from project. Prior to Final Acceptance, Contractor shall provide the Owner's Representative with all Record Drawings and written Guaranty Statements in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials used shall either conform to Specifications in other Sections or shall otherwise be acceptable to the Owner's Representative. The Owner's Representative shall be given a monthly record of all herbicides, insecticides and disease control chemicals used.

B. Maintenance Fertilizer: "Gro-Power High Nitrogen" as available through Gro-Power, Inc., 800-473-1307, or accepted equal, and shall contain the following chemical analysis:

Percent	Chemical
14%	nitrogen
4%	phosphoric acid
9%	potash

C. Humus: Inactive, decomposed organic material approved by Owner's Representative.

PART 3 - EXECUTION

3.01 MAINTENANCE

A. General: Proper maintenance, including watering, weeding, mowing, edging, fertilization, repairing, and protection is required until Final Acceptance of the entire project but not less than the specified Landscape Maintenance Period.

B. Watering: Water appropriately for each plant type to insure vigorous and healthy growth until work is accepted. Water or irrigate in a manner to prevent runoff or erosion. When hand watering, use a "water wand" to break the water force.

C. Weeding: Entire project site shall be kept free of weeds at all times. Control new weed growth with pre-emergent herbicides. If weeds develop, use legally approved herbicides.
   1. No herbicide shall be used without the Owner's Representative prior consent. Use herbicides in accordance with manufacturer's recommendations. If selective herbicides are used, extreme caution shall be observed so as not to damage other plants. Spraying shall only be done under windless conditions.
   2. Disease and Pest Control: Disease and insect damage shall be controlled by the use of fungicides and insecticides, subject to the prior consent of the Owner's Representative. Mole and gopher mitigation shall be accomplished using legal means other than poison baits.

D. Pruning:
   1. Trees: Prune trees to select and develop permanent scaffold branches; to eliminate narrow V-shaped branch forks that lack strength; to reduce potential toppling and wind damage by thinning out crowns; to maintain a natural appearance; and to balance crown with roots. Prune only as directed by the Owner's Representative.
   2. Shrubs: The objectives of shrub pruning are the same as for trees. Shrubs shall not be clipped into balled or boxed forms unless such is required by the design.
   3. All pruning cuts shall be made to lateral branches, buds or near flush with the trunk. "Stubbing" or heading cuts is not permitted.
   4. Only skilled workers shall perform pruning work in accordance with standard horticultural pruning practices. Remove from the project all pruned branches and material. Remove and replace plant material excessively pruned or malformed resulting from improper pruning practices at no additional cost to the Owner.

E. Staking: Stakes shall remain in place through the maintenance and guaranty periods and shall be periodically inspected and adjusted by the Contractor to prevent rubbing that causes bark wounds, loosen for proper growth or other appropriate reasons.

F. Protection: The Contractor shall maintain protection of planting areas until Final Acceptance. Damaged areas shall be repaired or replaced at the Contractor's expense. Install a temporary maintenance fence using 4-foot blaze orange with steel driven stakes, or acceptable equal, around all turf areas for the entire length of Landscape Maintenance Period.

G. Trash: Remove trash in all project areas plus adjacent pedestrian walkways and parking areas for the entire length of Landscape Maintenance Period.

H. Replacement: Refer to the Article "Guarantee" in Part 1.

3.02 IRRIGATION SYSTEM

A. System Observation: The Contractor shall visually check all systems for proper operation on a weekly basis and make necessary repairs. Equipment shall be adjusted as necessary for proper coverage and function.

B. Controllers: Program automatic controllers for appropriate seasonal water requirements. Perform a full instruction session in the presence of the Owner's designated maintenance personnel demonstrating programming, system testing, and trouble shooting. Include instructions on how to turn off system in case of emergency.

C. Repairs: Repairs made to the irrigation system shall be at the Contractor's expense. Repairs, when required, shall be made within 24 hours of discovery by either Owner or Contractor.

3.03 FIELD QUALITY CONTROL

A. Final Review:
   1. At, or near the end of specified Landscape Maintenance Period, the Contractor shall make a written request for a final review and the work shall be reviewed for conformance with the Construction Documents.
   2. If the work is not accepted at time of review, a punch-list of items requiring attention will be prepared by the Owner's Representative and issued to the Contractor for correction.
   3. The Landscape Maintenance Period shall be extended at Contractors sole cost, as necessary.
   4. Upon completion of the punch-list, the Contractor shall again make written request for review. If, upon re-visiting the site, it is found that the punch-list has not been completed, the review shall end and a subsequent visit shall not be scheduled until the Contractor can assure the Owner the work is complete. The incomplete punch-list review meeting and any further visits and reviews, and re-inspections required due to Contractor not being prepared, or non-conformance with the Construction Documents, shall be back charged to the Contractor.

B. Final Acceptance: When work is found to be in conformance with the Contract Documents, subject to the discretion of the Owner's Representative, a statement of Final Acceptance shall be issued to the Contractor.

END OF SECTION

SECTION 31 1000 - SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Removal of vegetation, grass, grass roots, shrubs, tree stumps, trees, upturned stumps, weed growth, tree roots, brush, masonry, concrete, rubbish, debris and other materials.
2. Removal of concrete and bituminous surfaces.
3. Removal of existing fences and gates.

B. Related Requirements

1. Division 01 - General Requirements.
2. Section 31 23 13 - Excavation and Fill.

1.02 SUBMITTALS

A. Shop Drawings: Submit site plan indicating extent of site clearing.

1.03 QUALITY ASSURANCE

A. Comply with Standard Specifications for Public Works Construction, current edition, as a minimum requirement.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 TREE AND STUMP REMOVAL

A. Remove trees and stumps indicated or required to be removed. Remove trees, together with bulk of roots, to a minimum depth of 4 feet below required grade, and within a radius of approximately 7 feet beyond perimeter of trunk at grade.

B. Fill and compact excavation from tree and stump removal. Fill in 6 inch layers, each compacted to 90 percent of maximum density in accordance with ASTM D1557.

1. Back filling shall not commence until the excavation is inspected and tested.

3.02 CONCRETE AND BITUMINOUS SURFACING REMOVAL

A. Break up and completely remove existing concrete surfacing, curbs, gutters, walks and bituminous surfacing to indicated limits. Cutting shall be performed to a neat and even line with proper tools or a concrete cutting saw. Minimum depth of cut shall be 1 1/2-inch, unless otherwise indicated. Remove concrete broken beyond the indicated limits to the nearest joint or score line and replace with new concrete to match existing.

3.03 CLEANUP

A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 31 2200 - GRADING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes general exterior grading, cutting and filling, including grading for building area, paving, planting areas, banks and hillsides.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 31 1000 - Site Clearing.
3. Section 31 2313 - Excavation and Fill.
4. Section 31 2326 - Base Course.

1.02 PROJECT REQUIREMENTS

A. General:

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.
4. Before grading, contact Underground Service Alert of Northern California (USANC) for information on public buried utilities and pipelines. Retain the services of an underground utility locator for on-site utilities.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Materials shall conform to requirements specified in this and related sections.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect and maintain installed stakes until their removal is required for the Work. Provide replacement grade or location stakes lost or disturbed.

B. Install grade stakes and compare to indicated grades. If discrepancies are found between existing grades and grades indicated on Drawings, do not proceed until discrepancies are resolved.

3.02 ROUGH AND FINE GRADING

A. Rough grade area sufficiently high to require cutting by fine grading:

1. Grade area for bituminous surfacing and other paving to the indicated grades, equal to the section of the indicated base and pavement.
2. Slope banks to required finish grades as cut progresses or leave cuts full and finish grade by mechanical equipment to provide grades and soil densities indicated on the Drawings.

3. Rough grade, fill and compact banks beyond indicated finish grades. Finish grade banks and slopes to indicated grades and specified soil densities.

4. Grade Only Areas: In areas not indicated to receive pavement, rough grade to approximate finish grades and then scarify, moisten and roll to obtain required density and indicated finish grades.

5. Tolerances: Finish grades shall be within a tolerance of 0.01 inch per foot above or below grades indicated. Provide an average grade as indicated.

B. Base or Subgrade:

1. After subgrade has been constructed to approximate required grades, scarify to a depth of at least 6 inches:

a. After scarifying, process loosened material to a finely divided condition and adjust moisture content to optimum condition by addition of water, addition and blending of dry suitable material, or by drying of existing material.

b. Subgrade material shall be compacted by tamping, sheepsfoot rollers or pneumatic tire rollers. Required relative compaction shall be 95% per ASTM D1557.

c. Install base course in accordance with Section 31 2326 - Base Course.

2. Tolerance of completed grades of base or subgrade shall not vary more than 0.03 inch per foot from grades indicated. Provide an average grade as indicated.

3.03 SHORING

A. Provide shoring as necessary to properly and safely support earth sides of excavations, and existing curbs, sidewalks, gutter, drives and stairs, against movement and collapse.

B. Design and Calculations: Provide in accordance with requirement of CalOHSA.

C. Remove shoring upon completion of the Work of this section or when no longer needed unless required otherwise by authorities having jurisdiction.

3.04 EXCESS MATERIAL DISPOSAL

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.05 PROTECTION

A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 31 2313 - EXCAVATION AND FILL

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes; or Project site pavement, planting areas, buildings, and other structures.

1. excavating,
2. filling,
3. moisture conditioning and recompaction.

B. Related Requirements

1. Division 01 - General Requirements.
2. Section 02 4100 Demolition
3. Section 31 23 26 – Base Course.

1.02 PROJECT REQUIREMENTS

A. Import and Export of Earth Materials

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.
4. Before grading, contact Underground Service Alert of Northern California (USANC) for information on public buried utilities and pipelines. Retain the services of an underground utility locator for on-site utilities

1.03 SUBMITTALS

A. Imported Soils: A geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain initial product Sample for testing in accordance with the terms of Article 3.05 of this section.

B. Shoring calculations as required in Article 3.03 of this section.

1.04 QUALITY ASSURANCE

A. Comply with the Standard Specifications for Public Works Construction, current edition, except as modified herein.

B. Sampling, testing, and certification of imported and exported soils shall be performed in accordance with Division 01.

PART 2 - PRODUCTS

2.01 CLEARED AND STRIPPED MATERIALS

A. Cleared Material--The Cleared materials shall be removed from areas to be graded and shall be disposed of in areas designated by the Owner.

B. Stripped Materials--Materials shall not be reused as compacted fill and shall either be removed from the site or stockpiled for later use in landscape areas, if required.

2.02 FILL AND BACKFILL MATERIALS

A. Fill material shall comply with the recommendations in the soils report. On-site soils are considered suitable for re-use. Fill material (imported or re-used) should be free of organic and other deleterious materials and have a maximum particle size no greater than 3 inches. Imported fill should be tested by the geotechnical consultant prior to import to the Site. Imported fill should be non-corrosive to concrete and ferrous metals and contain no more than 12 percent passing the no. 200 sieve by dry weight and have a plasticity index less than 7. Grain size distributions, Atterberg limits, maximum dry density and optimum water content (ASTM D1557) determinations should be made on representative samples of the proposed fill material before it is brought to the Site.

B. Bedding material for trenches shall meet the requirements in the soils report and shall extend from one foot below the bottom of the conduit or pipe to one foot above the pipe:

C. Other Fill Materials: Brick rubble and broken concrete originating from the Project site may be legally disposed of off the Project site, or incorporated in fill, if reviewed by a geotechnical engineer, retained by the Owner as an Owner Consultant. Unless otherwise indicated, no such material shall be imported from outside the Project site.

D. Select Backfill at Retaining Walls shall meet the requirements in the soils report.

E. Cement-sand slurry shall be provided as specified by CalTrans Standards.

2.03 BASE MATERIALS

A. Concrete Slabs on Grade: Provide "Crushed Aggregate Base" as specified in Standard Specifications for Public Works Construction, Section 200 - Rock Materials, with 3/4 inch maximum size aggregates. Provide 4 inch thick base, unless noted otherwise.

B. Bituminous Surfacing: Provide as indicated on Drawings and specified in Section 31 2326 Base Course

2.04 LIME FOR SOIL STABILIZATION

A. Lime shall be provided from a source approved by the Geotechnical Engineer.

PART 3 - EXECUTION

3.01 GENERAL

A. Before excavation, contact Underground Service Alert of Southern California (USASC) for information on buried public utilities and pipelines. For onsite utilities retain an underground utility identification service.

B. Where the Work includes a building extension or addition on an occupied Project site, perform Work in such a manner, and at such times, as not to disrupt performance of existing utility services to existing Project site facilities. Where an interruption is necessary, obtain review from the University Representative before proceeding.

C. Remove concrete or bituminous pavement to straight lines by saw cutting.

3.02 GEOTECHNICAL ENGINEER

A. The work covered by these specifications shall be performed under the observation of the Geotechnical Engineer, who shall be retained and paid by the Owner.

B. The Geotechnical Engineer will be present at the site intermittently to observe the work, and

to perform field and laboratory tests to evaluate material quality and compaction. The Contractor shall cooperate with the Geotechnical Engineer in performing the observations and tests. At the completion of his work, the Geotechnical Engineer shall submit a report to the Owner, including a tabulation of all tests performed. The Geotechnical Engineer's costs for observing and testing the repair of unsatisfactory work performed by the Contractor shall be billed to the Owner. The Owner shall pay them and then shall deduct the amount from monies due to the Contractor.

3.03 PREPARATION

A. Protect and maintain installed stakes until their removal is required for the Work. Provide replacement grade or location stakes lost or disturbed.

B. Install grade stakes and compare to indicated grades. If discrepancies are found between existing grades and grades indicated on Drawings, do not proceed until discrepancies are resolved.

3.04 PROTECTION

A. Protect and guard excavations against danger to life, limb, and property as required by, but not limited to, OSHA regulations.

B. Protect existing improvements including landscaping against damage. Repair or replace damaged items.

C. Protect existing utility services and distribution systems from damage or displacement.

D. Remove conduits or pipes not in service, exposed during Work, unless a minimum cover of two feet is provided. Remove concrete, clay or other non-metallic pipe over 8 inches in diameter, unless otherwise indicated.

E. Shore, crib, or lag excavations and earthen banks as necessary to prevent cave in, erosion or gullying of sides.

F. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. If soil becomes soft, soggy, or saturated, excavate to firm undisturbed earth and fill as required. Slope adjacent grades away from excavations to minimize entry of water.

3.05 TREE AND STUMP REMOVAL

A. Remove trees and stumps indicated or required to be removed. Remove trees, together with bulk of roots, to a minimum depth of 4 feet below required grade, and within a radius of approximately 7 feet beyond perimeter of trunk at grade.

B. Fill and compact excavation from tree and stump removal. Fill in 6 inch layers, each compacted to 90 percent of maximum density in accordance with ASTM D1557.

C. Back filling shall not commence until the excavation is inspected and tested.

3.06 CONCRETE AND BITUMINOUS SURFACING REMOVAL

A. Break up and completely remove existing concrete surfacing, curbs, gutters, walks and bituminous surfacing to indicated limits. Cutting shall be performed to a neat and even line with proper tools or a concrete cutting saw. Minimum depth of cut shall be 1 1/2-inch, unless otherwise indicated. Remove concrete broken beyond the indicated limits to the nearest joint or score line and replace with new concrete to match existing.

3.07 CLEARING AND STRIPPING

A. Clearing--The areas to be graded shall be cleared of all grass, brush, roots, rubbish, and debris.

B. Stripping--Where encountered, the upper natural soils containing grass, roots, and other vegetation shall be stripped from all areas to be graded. This material shall not be reused as compacted fill. Deep stripping in localized areas may be required by the Geotechnical Engineer to remove roots or other concentrations of vegetation.

3.08 SHORING

A. Provide shoring as necessary to properly and safely support earth sides of excavations, and existing curbs, sidewalks, gutter, drives and stairs, against movement and collapse.

B. Design and Calculations: Provide in accordance with requirement of governing Cal-OSHA requirements.

C. Remove shoring upon completion of the Work of this section or when no longer needed unless required otherwise by authorities having jurisdiction.

3.09 ROUGH AND FINE GRADING

A. Rough grade area sufficiently high to require cutting by fine grading:

1. Grade area for bituminous surfacing and other paving to the indicated grades, equal to the section of the indicated base and pavement.

2. Slope banks to required finish grades as cut progresses or leave cuts full and finish grade by mechanical equipment to provide grades and soil densities indicated on the Drawings.

3. Rough grade, fill and compact banks beyond indicated finish grades. Finish grade banks and slopes to indicated grades and specified soil densities.

4. Grade Only Areas: In areas not indicated to receive pavement, rough grade to approximate finish grades and then scarify, moisten and roll to obtain required density and indicated finish grades.

5. Tolerances: Finish grades shall be within a tolerance of 0.01 inch per foot above or below grades indicated. Provide an average grade as indicated.

B. Base or Subgrade:

1. After subgrade has been constructed to approximate required grades, scarify to a depth of at least 6 inches:

2. After scarifying, process loosened material to a finely divided condition and adjust moisture content to optimum condition by addition of water, addition and blending of dry suitable material, or by drying of existing material.

3. Subgrade material shall be compacted by tamping, sheepsfoot rollers or pneumatic tire rollers. Required relative compaction shall be 95% per ASTM D1557.

4. Install base course in accordance with Section 31 2326 - Base Course.

C. Tolerance of completed grades of base or subgrade shall not vary more than 0.03 inch per foot from grades indicated. Provide an average grade as indicated.

3.10 EXCAVATION

A. Unclassified Excavations: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork", except as modified herein.

B. Form sides of footings, pads, grade beams, and slab foundations, unless otherwise indicated. Provide excavations of sufficient size to permit installation and removal of forms and other required Work.

C. Machine-drill excavation for round footings to size and depth indicated. Provide a collar or casing, or other adequate protection, to exclude dirt and debris. Protect excavations with plank covers until concrete is placed.

D. Provide excavation bottoms level and free from loose material. Excavate to indicated or required elevations of undisturbed earth.

E. Barricade trenches, ditches, pits, sumps, and similar Work outside the barricaded working area with chain link fence as specified in Section 01 50 00 - Construction Facilities and Temporary Controls, and in accord with Cal-OSHA standards and requirements.

F. Trenches over five feet in depth shall comply with the Construction Safety Orders of the California Division of Industrial Safety.

G. Where indicated or required to excavate in lawn areas, protect adjoining lawn areas outside of the Work area. Replace or install removed sod upon completion of backfill by installing sod level with adjacent lawns. If installation of removed sod fails, furnish sod and install to match existing lawns.

H. For Structures:

1. Provide 2,000 psi concrete for backfill of over-excavated areas to indicated or required elevations.

2. Special preparation of bottom of excavated planes areas: Excavate areas shown on Drawings as bottom of excavated planes (B.E.P.), by excavating and filling to indicated grades and elevations.

3.11 IMPORT/EXPORT OF MATERIALS

A. Unclassified Fill and Compaction: Comply with the Standard Specifications for Public Works Construction, Section 300 - Earthwork, except as modified herein. Install and compact fill in layers not to exceed 6 inches in thickness.

B. Provide fill materials as specified in Part 2- Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.

C. In addition to the requirements of this section, import and/or exported materials shall comply with the requirements of Division 01.

D. Imported fill materials shall be sampled by a geotechnical engineer, retained by the Owner as an Owner Consultant, for compliance with the requirements of Part 2 of this section.

E. Initial sampling and testing shall be performed before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and entity responsible for the source site. A geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain both the initial and additional samples from the identified site and submit samples for required testing.

F. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1000 cubic yards of material, one sample shall be obtained and submitted for testing for each 200 cubic yards of imported material. If the total quantity of

import is determined to be less than 1000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.

G. The independent approved testing laboratory shall perform the required tests and report results of tests noting if the tested material passed or failed such tests and shall furnish copies to the Project Inspector, Architect, Contractor, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents and latest version of California Building Code. Upon completion of the Work of this section, the independent testing laboratory and geotechnical engineer shall submit a verified report as required by the latest version of the CBC.

H. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.

I. Upon completion of import operations, provide the Inspector a certification statement attesting that imported material has been obtained from the identified source site.

3.12 INSTALLATION OF MATERIALS

A. Subgrade Preparation: Following excavation of undocumented fill, soft and/or pumping materials, perched and/or standing water, and an otherwise unsuitable material shall be removed from the subgrade and foundation subgrade consisting of native soil shall be level and proof rolled. Proof rolling should be performed using an approved compactor such as a 5-ton roller compactor, or equivalent; static equipment is required for use if cohesive material is present; vibratory equipment is required for use if non-cohesive material is present. Exposed materials shall be mixed with granular materials to improve workability. Any soft, loose, or unsuitable soils identified by the geotechnical engineer during proof rolling and subgrade preparation shall be removed and replaced with approved compacted fill. The subgrade shall be observed and approved by a qualified geotechnical engineer prior to steel or concrete placement

B. Pavement: Fill or backfill materials shall be installed in horizontal layers of 4 inches, unless otherwise required. Each layer shall be evenly placed and moistened or aerated as necessary. Unless otherwise reviewed by the geotechnical engineer, retained by the Owner as an Owner Consultant, each layer of fill material shall cover the length and width of the area to be filled before the next layer of material is installed. Top surface of each layer shall be installed to an approximate level with a crown or crossfall of at least 1 in 50, but not more than 1 in 20. Provide adequate drainage at all times during installation of the Work of this section.

C. Structures

1. After concrete has been placed, forms removed, and concrete Work inspected, backfill excavations with earth to indicated or required grades. Backfill simultaneously on each side of walls or grade beams. Remove rubbish, debris and other waste materials from excavations before placing backfill.

2. Before placing backfill, adequately cure concrete and provide bracing, if required to stabilize structure. Protect waterproofing or damp-proofing against damage during backfilling operations, with required protection board. Remove bracing as backfill operation progresses.

3. Do not furnish or install expansive soils for retaining wall backfill.

4. Rigidly control the amount of water to be installed to provide optimum moisture content for type of fill material furnished. Do not over-saturate or compact by flooding or jetting.

5. Install wall backfill before installing railings and fences on walls.

6. Install weep hole drainage at the backside of walls so the backing completely covers the weep holes, is horizontally centered and extends at least 12 inches above the bottom of the weep opening. Provide an 8-inch square section of 1/4 inch galvanized or aluminum screen, with a minimum wire diameter of 0.03 inch, and install at the backside of each weep hole before installing the backfill material.

7. Where a reviewed drainage matting system is provided instead of permeable backfill for retaining structures, install in accordance with the manufacturer recommendations.

D. Utilities

1. Do not install backfill until the Work of this section has been inspected and tested. Do not furnish or install materials excavated from the Project site containing materials not permitted for backfill.

2. Backfill electrical or other excavated utility trenches located outside of barricaded installation areas within 24 hours after inspection by the UNIVERSITY REPRESENTATIVE.

3. Install backfill in layers not exceeding 4 inches in thickness, except cement-sand slurry.

4. If materials excavated from the Project site are not permitted for trench backfill in paved areas, backfill trenches with a cement-sand slurry mix. Install backfill to an elevation of the existing undisturbed grades plus one inch.

3.13 COMPACTING

A. General: On-site soils are considered suitable for re-use. Imported and re-used fill material shall be free of organic and other deleterious materials and have a maximum particle size no greater than 2 inches. Imported fill shall be tested by the geotechnical consultant prior to import to the site. Imported fill shall be non-corrosive to concrete and ferrous metals and contain no more than 12 percent passing the no. 200 sieve by dry weight and have a plasticity index less than 7. Grain size distributions, Atterberg limits, maximum dry density, and optimum water content (ASTM D1557) determinations shall be made on representative samples of the proposed fill material before it is brought to the site. Non-structural fill shall be placed in loose lifts no greater than 6 inches in thickness, moisture conditioned within 2 percent of optimum moisture content, and compacted to at least 95 percent of the laboratory maximum dry density as determined by ASTM D1557 (Modified Proctor). Structural fill placed within the building footprint, shall be placed in loose lifts no greater than 6 inches in thickness, moisture conditioned within 2 percent of optimum moisture content, and compacted to at least 98 percent of the laboratory maximum dry density as determined by ASTM D1557 (Modified Proctor). All fill placements shall be subject to controlled engineering observation and testing by the geotechnical consultant. No fill material shall be placed on areas where free water is standing or on surfaces which have not been approved by the geotechnical consultant

Utility Support: Utilities can be supported on grade, bearing on compacted engineered fill or approved native soils. In areas where utility inverts are within the fill material we recommend that these utility trenches extend a minimum of 1 foot below the design invert and that backfill material consist of material similar to a Caltrans Class 2 aggregate base or clean sand with a sand equivalent (S.E.) value of 30 or greater, or as approved by the utility owner. The gradation of the proposed fill shall be compared with the gradation of the native soils to determine if a separation fabric, such as Mirafi 140N or equivalent, is required between the two materials. The bedding material shall extend at least 12 inches over the top of the utility, unless otherwise required by the utility owner. Utility subgrade shall be confirmed to be free of standing water, firm and unyielding prior to placement of bedding material. Utility trenches above pipe bedding shall be backfilled in accordance with

the recommendations provided herein for fill compaction requirements using either previously excavated soil (if suitable), or with approved imported material. Utility trench backfill shall be compacted to 95 percent of the maximum dry density and moisture conditioned to within 2 percent of the optimum moisture content, as determined by ASTM Test Method D1557 (Modified Proctor compaction).

B. Each layer of fill material shall be compacted by tamping, sheepsfoot rollers, or pneumatic-tired rollers to provide specified relative compaction. At inaccessible locations, provide specified compaction by manually held, operated and directed compaction equipment.

C. Install and compact sand bedding to provide a uniform bearing under the full length of piping and conduits.

D. Unless otherwise indicated, compact each layer of fill material to a relative compaction of at least ninety percent.

E. When fill materials, or a combination of fill materials, are encountered or provided which develop densely packed surfaces as a result of installation or compacting operations, scarify each layer of compacted fill before installing the next succeeding layer.

3.14 LIME TREATMENT FOR SOIL STABILIZATION

A. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall direct when lime stabilization is to be employed.

B. All lime stabilization shall be overseen by the geotechnical engineer.

3.15 INSPECTION AND TESTING

A. The geotechnical engineer, retained by the Owner as an Owner Consultant, will inspect and test excavations, sample material quality for testing as set required in Part 2, and observe installation and compaction of fill materials.

B. The geotechnical engineer, retained by the Owner as an Owner Consultant, will sample imported fill materials from their designated source and submit samples to the independent approved testing laboratory before delivery to the Project site.

C. Installation of backfill shall be observed by the geotechnical engineer, retained by the Owner as an Owner Consultant.

D. The geotechnical engineer, retained by the Owner as an Owner Consultant, will inspect and test excavation Work before the installation of fill and other materials.

E. Compaction: Test compaction in accordance with ASTM D1557, Method C.

F. The Project Inspector will inspect foundation excavations when completed and ready for forms, after forms are in place, and before first placement of concrete.

3.16 SPILLAGE, DUST AND EROSION CONTROL

A. Spillage--The Contractor shall prevent spillage when hauling on or adjacent to any public street or highway. In the event that such occurs, the Contractor shall remove all spillage and sweep, wash or otherwise clean such streets or highways as required by local City and County authorities and/or the State of California.

B. Dust and Erosion Control--The Contractor shall take all precautions needed to prevent a dust nuisance to adjacent public or private properties and to prevent erosion and transportation of soil to downstream or adjacent properties due to his work under this contract. Any damage so caused shall be corrected or repaired by the Contractor at no cost to the Owner.

C. Owner's Prerogative--In the event the Contractor fails to take such precautions or make such corrections or repairs promptly, the Owner may take such steps as he may deem necessary

and deduct the cost of the same from the monies due to the Contractor. Any such action or lack of action on the part of the Owner in no way alters or relieves the Contractor for the proper protection of the work.

3.17 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.18 CLEANING

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil and waste materials, including unsatisfactory soil, trash, and debris and legally dispose of them off University property.

END OF SECTION

SECTION 32 1116 - BASE COURSE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes installation of aggregate base material for asphalt pavement.

B. Related Requirements

1. Division 01 - General Requirements.
2. Section 31 1000 - Site Clearing.
3. Section 31 2313 - Excavation and Fill.

1.02 SUBMITTALS

A. Prior to import, submit written certification to Owner's Representative that crushed Miscellaneous Base (CMB) does not contain Polychlorinated biphenyls (PCB) above laboratory detection limits when tested in accordance with EPA Method 8082, and obtain written approval from the Inspector of Record prior to import at the subject site, refer to Article 2.02 for sampling frequency.

B. Crushed aggregate base (CAB) shall consist of native rock without naturally occurring asbestos or recycled materials. The Contractor shall submit written documentation, which identifies the source, volume, and proposed transport date of the material for review and approval by the University prior to importing the material. A statement on company letterhead from the source, stamped by either a California Professional Geologist or Engineer, which states that the subject materials are native rock, do not contain any recycled materials and that the source does not mine ultramafic materials, a source of natural occurring asbestos shall be included in the submittal. The Contractor may request variance from testing by Section 01 4523 for CAB. To be considered for a variance, the Contractor shall submit a documentation package, which includes all of the aforementioned information at least 48 hours in advance of planned import.

C. Product Data: Submit material source, technical information, and test data for base materials. Gradation and quality certifications shall be dated within 30 days of the submittal.

D. Sample: Submit Sample of proposed base course material.

1.03 QUALITY ASSURANCE

A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction, current edition.

PART 2 - PRODUCTS

2.01 UNTREATED BASE MATERIALS

A. The following base materials shall conform to the requirements of the Standard Specifications for Public Works Construction: Section 200 - Rock Materials.

1. Crushed Aggregate Base.
2. Crushed Miscellaneous Base.
    a. CMB meeting requirements of Article 1.02, A, may be used on-site for pavement base only.
    b. CMB may be used off-site when in accordance to the Greenboook.

B. Materials generated on site shall not be used as a base course material.

2.02 SOURCE QUALITY CONTROL

A. Sampling and testing of imported and/or exported crushed miscellaneous base (CMB) shall be performed at the rate of one sample per 250 cubic yards of material.

2.03 MATERIAL APPROVAL

A. Base material shall be inspected by the Project Inspector for gradation and material content prior to installation. The owner may choose to have additional tests performed by a geotechnical engineer, retained by the Owner, before installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install base course material in layers not exceeding 4 inches in thickness, unless required otherwise. Grade and compact to indicated levels or grades, cut and fill, water and roll until the surface is hard and true to line, grade and required section. Provide a relative compaction of at least 95 percent as determined by ASTM D1557 (Modified Proctor), unless otherwise required.

B. Aggregate base shall be moisture conditioned to within 2 percent of optimum moisture content as determined by ASTM D1557 (Modified Proctor).

3.02 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.03 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 32 1123– PAVEMENT SUBBASE AND BASE COURSES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This work shall consist of furnishing, spreading, and compacting aggregate base as specified in the Contract Documents. The work shall conform to Section 26 of the Caltrans Standard Specifications except as indicated in the Contract Documents.

1.02 RELATED DOCUMENTS

A. Unless otherwise specified, the work embraced herein shall conform to:

1. The Contract Documents (including but not limited to plans, project geotechnical reports, and project arborist reports).

2. The appropriate specifications of the Caltrans Standard Specifications insofar as the same may apply.

B. In the event of apparent conflicts between the Standard Specifications, the Standard Plans, the Standard Details, or the Contract Documents, those requirements, as determined by the Engineer, which gives the greatest protection to the owner or result in the best installation shall govern.

PART 2 - PRODUCTS

2.01 AGGREGATE BASE ROCK

A. Unless otherwise specified in the Contract Documents, aggregate base shall be Class 2 (3/4-inch maximum size material) aggregate base conforming to Section 26 of the Caltrans Standard Specifications.

2.02 WATER

A. Water for dust control, general cleaning, moistening and compaction shall be from the potable water system, the recycled water system, or another approved source. Prior to use of potable water, the contractor must obtain a portable water meter and arrange payment for water used.

PART 3 - EXECUTION

3.01 SUBGRADE - The subgrade to receive aggregate base, immediately prior to spreading, shall meet the requirements of Alternate Section, Earthwork. Specific attention is directed to the relative compaction and subgrade "Truck Load Test" requirements.

3.02 FINISHED GRADE OF AGGREGATE BASE - The surface of the finished aggregate base at any point shall meet the design grade indicated in the Contract Documents or as established by the Engineer with an allowed tolerance of not more than 0.04 feet above or below the above indicated grade.

3.03 SPREADING AND COMPACTING shall conform to Sections 26-1.03C and 26-1.03D of the Caltrans Standard Specifications, except the grade tolerance of the finish grade of the aggregate base shall be as specified above.

3.04 TEST METHODS

A. The relative compaction of compacted aggregate base shall not be less than 95%, as determined by Test Method ASTM 2922.

B. Certificate shall be furnished to the Engineer, indicating conformance to the requirements as outlined in Section 26 of the Caltrans Standard Specifications, for the purpose of qualifying the aggregate base at the quarry. However, acceptance of the aggregate base by the Engineer will be determined solely by tests of samples taken at the job site.

C. The Contractor shall perform a "Truck Load Test," as provided in Alternate Section, Earthwork, on the finished grade of the aggregate base prior to covering with the next layer of material. The Contractor shall correct any failure of the aggregate base to pass the "Truck Load Test." Corrective measures are to be approved by the Engineer.

D. The number of tests will be determined by the Engineer in order to assure compliance with the Contract Documents. The Contractor shall pay for retesting of material that fails any compliance test.

3.05 REJECTED WORK

A. Any and all materials and/or workmanship not conforming to the Contract Documents shall be made to conform to said requirements to the satisfaction of the Engineer, at the expense of the Contractor, or shall be rejected. All rejected materials shall be removed from the site and shall be replaced with materials meeting the above requirements. No further compensation shall be allowed.

B. Earthwork shall comply with Section 19 of the Caltrans Standard Specifications except as provide for in this Section or elsewhere in the Contract Documents. Specifically excluded from this Section is trench excavation that is covered in Alternate Section, Furnishing and Installing Pipe.

END OF SECTION

SECTION 32 1216 – ASPHALTIC CONCRETE PAVEMENT, AND BERMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This work shall consist of furnishing and placing asphaltic concrete pavement for use in pavement, and the construction of berms. The work includes mixing aggregate and asphalt binder at a central mixing plant, spreading and compacting the mixture, and furnishing and applying prime coat, tack coat and, when required, pavement reinforcing fabric, upon a prepared roadbed, base or over existing pavement, to the lines, grades, and dimensions shown in the Contract Documents. This item shall conform to Section 39 of the Caltrans Standard Specifications, insofar as it is applicable.

1.02 RELATED DOCUMENTS

A. Unless otherwise specified, the work embraced herein shall conform to:

1. The Contract Documents (including but not limited to plans, project geotechnical reports, and project arborist reports).

2. The appropriate specifications of the Caltrans Standard Specifications insofar as the same may apply.

B. In the event of apparent conflicts between the Standard Specifications, the Standard Plans, the Standard Details, or the Contract Documents, those requirements, as determined by the Engineer, which gives the greatest protection to the owner or result in the best installation shall govern.

PART 2 - PRODUCTS

2.01 PRIME COAT

A. The prime coat shall consist of liquid asphalt SC-70 conforming to Section 93 of the Caltrans Standard Specifications and spread at the rate of 0.25 gallons per square yard of surface. Prior to placement of asphaltic concrete, the prime coat shall have attained a minimum penetration of one-quarter (1/4") inch. Paving over areas where puddling of excess un- penetrated prime coat exists shall not be allowed. Immediately in advance of placing asphaltic concrete, additional prime coat shall be applied as directed by the Engineer to areas where the prime coat has been destroyed and no additional compensation shall be allowed for this work. A sand blotter shall be applied in specific locations to the prime coat as directed by the Engineer in order to maintain vehicular and/or pedestrian traffic.

2.02 PAINT BINDER (TACK COAT)

A. Paint Binder (Tack Coat) shall be asphaltic emulsion RS1 conforming to Section 94 of the Caltrans Standard Specifications and its application shall conform to Subsection 39-4.02 of the Caltrans Standard Specifications.

2.03 MINERAL AGGREGATE

A. Coarse aggregate shall be clean, hard, tough, durable and sound. It shall be of a uniform nature and free from organic impurities or other deleterious substances. Fine aggregate shall consist of hard, durable, and sound sand. Separation of the natural material passing the No. 4 sieve from the crushed material passing the No. 4 sieve is NOT required.

B. When the combined grading of the course and fine aggregates is deficient in material passing the No. 200 sieve, a commercial filler may be added in conformance with Subsection 39-3.03 of the Standard Specifications.

C. The combined mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, shall conform to the following gradation when determined by Test Method No. Calif. 202:

Sieve Size	Base Course	Surface Course
1"	100	---
3/4"	95 - 100	100
1/2"	75-90	95-100
3/8"	65 - 80	80 - 95
No. 4	45 - 60	55 - 72
No. 8	30 - 45	38 - 55
No. 30	20 - 30	20 - 35
No. 200	3 - 7	4 - 9

2.04 ASPHALT

A. Bituminous binder shall be Performance Grade PG 70-10 asphalt conforming to Section 92 of the Caltrans Standard Specifications. Certification of the above shall be furnished to the Engineer.

B. The exact amount of asphalt binder shall be determined as provided in Section 39-2.01 of the Caltrans Standard Specifications except that the Contractor shall determine the quantity of asphalt binder per Calf. 367 and submit the mix design to the Engineer for approval.

2.05 PAVEMENT REINFORCING FABRIC AND ASPHALT BINDER

A. Pavement Reinforcing Fabric shall be placed at locations required by the Contract Documents and as required by the Engineer. Pavement reinforcing fabric shall be non-woven, bonded polypropylene-nylon, needle punched, thermally bonded on one side materials conforming to the following when tested in conformance with the listed ASTM Designation or AASHTO M288-96:

Specification	Requirement
Weight, Oz./S.Y., ASTM D3776	4.1
Grab tensile strength in pounds, ASTM	101
Elongation at break in percent, ASTM	50 Min.
Fabric Thickness in mils, ASTM D461	30 to
Mullen burst strength in psi, ASTM	200
Asphalt retention of fabric in gal/sy	0.25
ASTM D6140 oz/sy	26.9

B. The Contractor shall submit material certificate for pavement reinforcing fabric at the Preconstruction Conference for approval. If there is no Preconstruction Conference, the Contractor shall submit certification at least three (3) working days before initial placement of this material.

C. The fabric shall be protected from exposure to ultraviolet rays until placed.

2.06 PAVEMENT REINFORCING GRID

A. Pavement reinforcing grid shall be furnished and placed at all locations required by the Contract Documents and as directed by the Engineer. Pavement reinforcing grid shall be a self-adhesive, grid and conform to the following:

Specification	Requirements
Tensile strength, pounds per square inch, width and	1000 lbs./inc
Elongation at break, percent	5%
Melting point, degrees Fahrenheit	425
Adhesive Backing	Pressure
Grid Size	1 inch x

B. The Contractor shall submit material certificate and manufacturer's instructions for pavement reinforcing grid at the Preconstruction Conference to the Engineer for approval. If there is no Preconstruction Conference, submit required documents at least three (3) working days prior to initial placements.

2.07 BITUMINOUS SEALS

A. Bituminous Seals shall be of the type designated in the Contract Documents.

2.08 MISCELLANEOUS PORTLAND CEMENT CONCRETE

A. Miscellaneous Portland cement concrete is used for adjusting manholes and monuments where necessary. Miscellaneous Portland cement concrete shall be as provided in Alternate Section, Storm Sanitary Sewer Manholes, Drainage Structures, and Miscellaneous Structures, except that combined aggregate grading of 1 inch maximum shall be used.

2.09 MORTAR

A. Cement Mortar used in raising manholes and similar structures shall be composed of one part Portland cement and two (2) parts sand by volume. Sand shall be well graded and sized to all pass a #8 sieve. The materials shall be mixed to a consistency suitable for the purpose intended. Mortar shall be used within thirty (30) minutes after the mixing water has been added. Cement mortar shall achieve a minimum compressive strength of 2,000 psi in twenty-eight (28) days. The design of the cement mortar mix is subject to the approval of the Engineer.

2.10 WATER

A. Water for use in asphaltic emulsions shall conform to Section 37-2.02B of the Caltrans Standard Specifications. The source shall be approved by the Engineer. If water from the Campus potable water supply is used, the contractor must obtain a portable water meter from the Campus Water and Sewer Utility and arrange payment for water used.

B. Water for use in concrete and mortar mixes shall conform to Section 902.03 of the Caltrans Standard Specifications. To use the Campus potable water, the contractor must obtain a portable water meter from the Campus Water and Sewer Utility and arrange payment for water used.

C. The combined aggregate grading for asphaltic concrete for use in dikes shall be Surface Course, one-half (1/2") inch maximum size aggregate, as specified in Subsection 2.0, Materials, of this Section. The amount of asphalt binder used for asphaltic concrete berms shall not be less than eight percent (8%) by weight of the aggregate unless otherwise indicated in the Contract Documents.

PART 3- EXECUTION

3.01 PREPARATION

A. Prior to installing asphaltic concrete leveling course, pavement reinforcing fabric, pavement reinforcing grid or resurfacing, all raised pavement markers and thermo plastic pavement markings shall be removed and the surface shall be thoroughly cleaned of dirt, debris, sand, gravel, leaves and other deleterious material. Any weeds or vegetation existing in cracks in the pavement or at the edges of gutters or other surfaces shall be removed.

B. Whenever asphaltic paving material is being placed on existing pavement, a tack coat of asphaltic emulsion shall be applied to all surfaces prior to resurfacing work, in the manner prescribed in Subsection 39-4.02 of the Standard Specifications.

3.02 SPREADING AND COMPACTING

Spreading and compacting of all mixtures shall conform to Subsection 396 of the Caltrans Standard Specifications, except as indicated below or in the Contract Documents.

A. SPREADING

1. All Asphaltic Pavement shall be placed with self-propelled mechanical spreading asphalt paving machines with a screed and finishing equipment. The paving machine shall be of the type in which asphalt is delivered from trucks into the paving machine. Pick-up machines shall not be allowed without written approval of the Engineer. Truck drawn portable asphalt spreaders may be used in certain areas providing prior approval is granted by the Engineer.

2. All asphaltic paving materials delivered for paving streets, drives, alleys and other public ways shall be accompanied with an official weight tag from the asphalt plant, with each load. All costs for furnishing weight tags shall be included in the cost of Asphaltic Pavement.

3. Asphaltic Pavement shall be spread and compacted in layers not to exceed two (2) inches on any surface course and shall not exceed three (3) inches on any non- surface course unless provided for in the Contract Documents. Asphaltic Pavement shall be placed to the minimum thickness required by the Contract Documents in as many lifts as required to meet the above thickness requirements. All mixtures, except open graded mixture, shall be spread at a temperature of not less than 225 degrees Fahrenheit and all initial rolling and tamping shall be performed when the temperature of the mixture is such that the sum of the air temperature plus the temperature of the mixture is between 280 degrees Fahrenheit and 375 degrees Fahrenheit. Open graded mixture shall be spread at

a temperature suitable for workability. Edges shall be feathered when directed by the Engineer. A feathered edge is considered incidental and therefore no extra payment will be made.

4. All mixtures shall be placed only when the atmospheric temperature is above 50 degrees Fahrenheit.

5. The Contractor shall seal, and sand all conforms and edges where pavement is feathered to meet grade.

B. COMPACTING

1. Pneumatic-tire rolling shall be required only when so stated in the Special Provisions.

2. Initial or breakdown rolling shall consists of one complete coverage of asphalt mixtures and shall be performed with a tandem or a three-wheel roller. Such roller shall weigh not less than 12 tons, unless otherwise permitted by the Engineer.

3. In all other respects, spreading and compacting of all mixtures shall conform to Sub- section 39-6, Spreading and Compacting, of the Caltrans Standard Specifications.

3.03 ADJUSTMENT OF WATER VALVE BOXES

A. On new street construction or multiple course overlay of an existing street: Prior to the placement of the surface course of asphaltic pavement, water valve boxes will be raised to the elevation of the top of the base course. After the base course has been completed and before work on the surface course is commenced, the Contractor shall supply and place pre-cast rings on the valve boxes before starting the surface course. The rings will be of the proper thickness to raise the valve box to finished grade. The boxes shall be raised prior to priming. The Contractor shall be required to make any adjustments necessary for proper elevation of valve boxes. On single course overlay only: Buried water valves or those deemed by the engineer to be noticeably out of plain with the future finish grade shall have the box adjusted. All shall have adjustment rings installed per this section.

B. On existing pavements where resurfacing is to be constructed, water valve boxes shall be adjusted by the Contractor. Prior to paving, the Contractor shall install one or more adjusting rings on the valve box to bring it to the finished pavement grade and tie-out each water valve box as specified in Subsection 5.10 of this Section. Because of localized deflections in the pavement, the adjustment ring or rings may not be the same height as the nominal pavement thickness.

C. Where the resurfacing or capping is done in two lifts, rings shall be placed on valve boxes to the proper elevation in advance of the construction for each lift.

D. It is important that Campus crews have access to water valves at all times in case of an emergency.

E. The Campus will furnish the adjusting rings for Contractor to install. Contractor shall coordinate with the Engineer when Contractor is ready to pick-up the adjusting rings.

3.04 ADJUSTMENT OF MANHOLES

A. Description

1. Storm drain and sanitary sewer manholes shall be constructed to the taper (cone) section. The manholes shall be covered with a temporary steel plate that is safe

for traffic and does not allow dirt and debris to enter the pipe system. After the placement of the final lift of pavement, the manholes shall be brought to finish grade, installing the manhole frame and cover in accordance with the Standard Details and the Contract Documents.

B. Tolerance

1. The grade tolerance for adjusting all manholes and other facilities in the road shall be a maximum of 1/8 inch above to 1/4 inch below the finished grade of the final lift of asphaltic concrete. The adjusted manhole frame shall be firmly and uniformly supported using solid, durable material so that no rocking of the assembly occurs. The Contractor shall raise or lower manholes, flushing inlets, and catch basins not at finished grade in conformance with the Standard Details and the Contract Documents. Unless otherwise indicated in the Contract Documents, the Contractor shall properly locate and tied off to a minimum of two (2) locations for triangulation all manholes, flushing inlets, and catch basins within the project area in advance of paving operations to the satisfaction of the Engineer. Markings shall be done by semipermanent marks of paint/ink on the concrete gutter surface nearest to the manhole, flushing inlet, or catch basin being marked. Where concrete gutter does not exist, markings shall be done as directed by the Engineer.

2. Openings of these facilities shall be covered and made safe for the public use of the roadway.

3. Where the existing frame base, frame and/or cover is judged unserviceable by the Engineer or where adjustable grade extension rings are discovered, replacement units will be provided to the Contractor by the Campus. The handling of these units shall be considered incidental work and included in the payment for other items of work involved and no additional compensation will be allowed.

4. On pre-cast manholes, the Contractor shall raise or lower the manhole frame and cover by adding or removing pre-cast concrete grade rings and grouting the manhole frame to proper grade.

5. On brick manholes, the Contractor shall raise or lower the manhole frame and cover by adding or removing the proper courses of brick and grouting the manhole frame to the proper grade. Care shall be exercised when lowering a manhole that the top of the manhole is finished to the proper diameter so that the frame shall have sufficient bearing. Blocking the frame up with wood or similar material shall not be allowed. All work shall be done as directed by the Engineer.

6. Because of the damage to vehicles using public streets and the inconvenience to the public caused by incomplete street work, the Campus will not tolerate procrastination between adjustment stages in adjusting units to grade. Once the pavement is cut and work begun, the work must be properly scheduled and diligently prosecuted so that each unit is complete to its new grade, paving in place and barricades removed (no barricading overnight), all within a two (2) Working Day period from the commencement of work in the vicinity of each unit to be adjusted. At no time shall there be a drop off greater than 0.1' (one-tenth of a foot) in the pavement overnight.

7. As a matter of public safety, the Contractor shall ensure that manhole, valve box, flush inlet, and other covers are installed on their rings anytime the opening is left unattended.

3.05 TESTING

A. Testing and Coring

1. Testing shall conform to the requirements of Sections 39 and 92 of the Caltrans Standard Specifications.

B. Finished Surface

1. The smoothness of the finished pavement surface shall meet the requirements of Section 39-6.03 of the Caltrans Standard Specifications.

C. Rejection

1. Any and all materials and work not conforming to the above requirements shall be corrected in a manner satisfactory to the Engineer or shall be removed from the job site at the expense of the Contractor, said material to be replaced with new material, at no cost to the Campus, conforming to the above requirements to the satisfaction of the Engineer.

D.

3.06 PAVEMENT REINFORCING FABRIC

A. Asphalt binder for pavement reinforcing fabric shall conform to Section 92 of the Caltrans Standard Specifications and shall be Performance Grade PG 7010. Asphalt binder for pavement reinforcing fabric shall be applied at an approximate rate of 0.25 gallon minimum per square yard of surface covered. The exact rate of application shall be determined by the Engineer. The width of the asphalt binder spread shall be the width of the fabric mat plus three (3) inches on each side. Area of wedge cut shall be sprayed at a rate of 0.05 gallon per square yard first, followed by the full width spraying or 0.25 gallon per square yard, or as directed by the Engineer.

B. The fabric shall be stretched, aligned, and placed on the pavement surface with the smooth thermally bonded side up, and with no wrinkles that lap. The test for lapping shall be made by gathering together the fabric in a wrinkle. If the height of the doubled portion of extra fabric is one-half (1/2") inch or more, the fabric shall be cut to remove the wrinkle, then lapped in the direction of paving. Should the height of the doubled portion exceed two (2) inches, it shall be cut back to two (2) inches, then lapped in the direction of paving. For straight sections of roadway, no more than one fabric cut in thirty (30) linear feet of fabric laid will be allowed. For curved sections, the interval shall be ten (10) feet.

C. All areas that will receive asphaltic concrete will also have fabric installed when required by the Construction Documents or by the Engineer. These areas will include all conform areas, such as wedges at intersections and at lip of concrete gutters. Manual lay down methods shall be used only for irregular areas that are to be paved. The fabric shall be unrolled, stretched, aligned, and placed in increments of approximately thirty (30) feet.

D. Adjacent borders of the fabric shall be lapped two (2") to four (4") inches. The preceding roll shall lap two (2") to four (4") inches over the following roll in the direction of paving at ends of rolls or at any break. At fabric overlays, both the binder and the fabric shall overlap the previously placed fabric by the same amount.

E. Seating of the fabric with rolling equipment after placing shall be permitted. Turning of the paving machine and other vehicles shall be gradual and kept to a minimum to avoid damage.

F. A small quantity of asphalt concrete, to be determined by the Engineer, may be spread over the fabric immediately in advance of placing asphalt concrete surfacing in order to prevent fabric from being picked up by construction equipment. If bleeding of asphalt binder through reinforcing fabric occurs, the Contractor shall spread a thin layer of asphalt concrete on all reinforcing fabric in place.

G. Public traffic shall not be allowed on the bare reinforcing fabric, except that public cross traffic shall be allowed to cross the fabric, under traffic control, after the Contractor has taken every effort to prevent the fabric from being displaced.

H. Care shall be taken to avoid tracking binder material onto the pavement reinforcing fabric or distorting the fabric during seating of the fabric with rolling equipment. If necessary, exposed binder material shall be covered lightly with sand.

3.07 PAVEMENT REINFORCING GRID

A. After cleaning and drying the surface, a tack coat of Performance Grade PG 70-10 asphalt conforming to Section 92 of the Caltrans Standard Specifications followed by a leveling course of asphalt concrete shall be placed as required. Asphalt concrete leveling course shall conform to Subsection 5.4, Asphalt Concrete Leveling Course, of this Section.

B. Pavement reinforcing grid shall be placed on the leveling course to the width determined by the Engineer. Placement of the pavement reinforcing grid, including longitudinal and transverse overlap limits, shall be in accordance with the manufacturer’s recommendations. The pavement surface temperature shall not be greater than 140 degrees Fahrenheit when placing the pavement reinforcing grid unless approved by the Engineer. The grid shall be laid by mechanical means or by hand with sufficient tension to eliminate wrinkles.

C. The pavement reinforcing grid and asphaltic binder may be rubber tire rolled sufficiently to activate the adhesive and to adhere the grid to the pavement surface. The reinforcing grid shall be paved with asphalt concrete on the same day it is installed.

D. All work shall be done in accordance with the manufacturer's specification.

3.08 SPREADING AND COMPACTING

A. Spreading and Compacting shall be in accordance with Subsection 3.1, Spreading and Compacting, of this Section. The Contractor shall seal and sand all conforms and edges where pavement is feathered to meet grade.

B.

3.09 ADJUSTMENT OF SURVEY MONUMENT BOXES

A. Survey monument boxes shall be adjusted to grade prior to resurfacing if the monument has a standard box and cover and adjustment can be made with an adjustment ring. Where a monument does not have a box or where an old style square box exists, a box shall be installed after the paving operation in accordance with the Caltrans Standard Drawings. Care shall be used in working with survey monuments since they are controlled by the State of California Land Surveyor's Act. Damaged monuments that need to be replaced will need to be resurveyed by a Licensed Land Surveyor and appropriate documentation filed with the County Recorder at the expense of the contractor.

3.10 - ASPHALTIC CONCRETE DIKES

A. Asphaltic Concrete dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required lines, grades and cross section.

END OF SECTION

SECTION 32 1300 - SITE CONCRETE WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of the General Contract shall apply to this section.

B. Section Includes:

1. Portland cement concrete pavement, cement walks, curbs, gutters, trash pick-up area, ramps, mowing strips, fence post footings, sliding gate concrete tracks, catch basins, pipe bedding and encasements, thrust blocks, transition structures, flagpoles and light standard bases and footings, athletic equipment footings and equipment pads.

C. Related Sections:

1. Section 31 2200: Grading

1.02 SUBMITTALS

A. Shop Drawings: Submit plans, elevations and details of concrete site Work.

B. Product Data: Submit mix designs and manufacturer's technical data for materials and products. Submit 36" x 36" concrete Sample of each specified color.

1.03 QUALITY ASSURANCE

A. Comply with Standard Specifications for Public Works Construction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete, Mortar and Related Materials: Comply with applicable provisions of Standard Specifications for Public Works Construction, Section 201 - Concrete, Mortar and Related Materials:

1. Concrete: 28-day compressive strength 3,250 psi, unless specified otherwise.

2. Reinforcing Mesh: ASTM A 185, 4x4/W1.4 x W1.4 welded wire mesh.

3. Expansion Joint Filler: Preformed expansion joint filler, bituminous type, complying with ASTM D 994.

B. Form Materials:

1. Side forms: Douglas fir, Construction Grade or Better or metal forms.

2. Stakes: Douglas fir, Construction Grade or Better or metal stakes.

C. Concrete Parking Bumpers:

1. Precast concrete, smooth and free of pits and rock pockets, providing a minimum 28-day compressive strength of 3,500 psi. Size at least 7-1/2 inches wide, 5-1/2 inches high and 6 feet long. Reinforce with 2 #5 reinforcing bars. Provide 2-3/4 inch diameter pre-drilled holes for anchor installation.

2. Bumper Anchors: Provide ½-inch diameter x 18-inch long galvanized steel pipe.

3. Bumper Adhesive: Provide adhesive recommended by bumper manufacturer/installer for fastening bumpers to concrete pavement.

PART 3 - EXECUTION

3.01 CONSTRUCTION OF FORMS FOR CAST-IN-PLACE STRUCTURES

A. Concrete Pavement: Install Portland cement concrete pavement in compliance with the Standard Specifications for Public Works Construction, Section 302- Roadway Surfacing.

B. Miscellaneous Exposed Concrete: Install concrete curbs, walks, gutters, cross gutters, access ramps, driveways, catch basins, yard boxes, vaults and similar structures, in compliance with the Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction.

C. Exposed Concrete Bases: Install bases, such as for post, flagpole, light standards and similar bases, in compliance with the Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction.

D. Post, flagpole, light standard footings below grade, underground conduit bedding, encasements, thrust blocks and similar structures may be placed \directly in excavations conforming to the required sizes.

E. Reinforcement installation and concrete placement, surface finishes, curing and removal of forms shall be performed in compliance with applicable provisions of Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction. Provide heavy broom finish at slopes exceeding six (6) percent and medium broom finish at slopes up to six (6) percent.

3.02 INSTALLATION OF PARKING BUMPERS

A. Install bumpers as indicated on the Drawings. On bituminous paving, install anchors through pavement and into the ground a minimum of 12 inches. On concrete pavement, install bumpers in a continuous bed of adhesive.

3.03 CLEAN UP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.04 PROTECTION

A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 32 1613 – PORTLAND CEMENT CONCRETE CURB, GUTTER, SIDEWALK, WALKWAY, CURB RAMP, AND DRIVEWAY

PART 1 - GENERAL

1.01 DESCRIPTION

A. This item shall consist of constructing Portland Cement Concrete Curbs, Gutters, Sidewalks, Walkways, Curb Ramps, Driveways and other miscellaneous work as required by the Contract Documents. The work shall conform to the Standard Details and Section 73 of the Caltrans Standard Specifications, insofar as it is applicable.

B. Sidewalk, curb and gutter sections shall be poured monolithically unless otherwise provided for in the Contract Documents or allowed by the Engineer. All work shall utilize fixed forms except that curbs, curb and gutter, sidewalks and monolithic sidewalk, curb and gutter sections may be placed using slip forms or extrusion machines with the approval of the Engineer.

1.02 RELATED DOCUMENTS

A. Unless otherwise specified, the work embraced herein shall conform to:

1. The Contract Documents (including but not limited to plans, project geotechnical reports, and project arborist reports).

2. The appropriate specifications of the Caltrans Standard Specifications insofar as the same may apply.

B. In the event of apparent conflicts between the Standard Specifications, the Standard Plans, the Standard Details, or the Contract Documents, those requirements, as determined by the Engineer, which gives the greatest protection to the owner or result in the best installation shall govern.

PART 2 - PRODUCTS

2.01 PORTLAND CEMENT

A. Unless otherwise specified in the Contract Documents, all cement used shall be of one brand, be Type II, and shall conform to ASTM C150. Results from certified tests, made by a recognized testing laboratory, shall be furnished by the cement manufacturer on request of the Engineer.

2.02 PORTLAND CEMENT CONCRETE

A. Concrete mix designs shall be submitted to the Engineer for approval a minimum of one week in advance of use. If the concrete supplier has a Campus approved mix design on file, the contractor must provide documentation indicating the supplier and the mix number at least twenty-four (24) hours in advance of use. Unless otherwise noted in the Contract Documents, Portland cement concrete shall contain at least six (6) sacks (564 pounds) of Type II Portland cement per cubic yard conforming to Section 90 of the Caltrans Standard Specifications. All cementitious material shall be Portland cement.

B. Poured In Place Concrete

1. The combined aggregate grading for poured in place Portland cement concrete shall be one inch (1") maximum as noted in Section 90 of the Caltrans Standard Specifications.

C. Slip Form/Extruded Concrete

1. Concrete placed using either the slip form or extrusion methods shall have an air entraining agent added during mixing in an amount to produce from five percent (5%) to eight percent (8%) air by volume in the mixed concrete.

2.03 AGGREGATES

A. Poured In Place Concrete

1. Aggregates for concrete shall conform to Section 90 of the Standard Specification. Combined aggregate grading shall conform to the one inch (1") maximum requirements of Section 90-3.04 of the Caltrans Standard Specifications.

B. Slip Form/Extruded Concrete

1. The combined aggregate for concrete placed by either the slip form or extrusion method shall conform to the following gradation:

Sieve Size	3/8" Maximum (Pea Gravel) Percentage Passing
1/2"	100
3/8"	85- 100
No. 4	60- 80
No. 8	40- 60
No. 16	25- 40
No. 30	15- 25
No. 50	6- 16
No. 100	1- 5
No. 200	0- 2

2. The above grading limits shall be further restricted if necessary, to produce concrete that after extrusion has well defined web marks of water on the surface and is free from surface pits larger than three-sixteenths inch (3/16") in diameter.

2.04 REINFORCING STEEL

A. Reinforcing steel shall conform to Section 52 of the Caltrans Standard Specifications.

2.05 WATER

A. Water for use in concrete mixes shall conform to Section 90-2.03 of the Caltrans Standard Specifications. Water for sub-grade and cushion shall be from the Campus potable water system, recycled water system, or another approved source. To use the Campus potable/recycled water, the contractor must obtain a water meter from the Campus Water and Sewer Utility and arrange payment for water used. Recycled water may be available through the Campus Water and Sewer Utility.

2.06 ADMIXTURES

A. No admixtures, accelerators, or retarders shall be allowed without the express approval of the Engineer unless required in the Contract Documents. Submittals for use of admixtures, including a mix design incorporating the admixture, shall be made a minimum of one (1) week in advance of the actual use.

2.07 AGGREGATE BASE

A. Base material shall be Class 2 Aggregate Base in accordance with Section, Aggregate Base.

2.08 EXPANSION JOINTS

A. Expansion joints shall consist of prepared strips of three-eighths inch (3/8") thick premolded joint filler conforming to the specifications of ASTM Designation D 1751.

PART 3 - EXECUTION

3.01 Contractor shall furnish to the Engineer a Certificate of Compliance signed by the supplier of the plant mix concrete. Certificate of Compliance shall state that the concrete furnished complies in all respects with the requirements of the Contract Documents. A Certificate of Compliance shall be furnished with each lot of material delivered to the work and the lot so certified shall be clearly identified in the Certificate.

3.02 SUBGRADE PREPARATION

A. The existing material shall be excavated to the required depth per the Contract Documents. The finished sub-grade immediately prior to placing subsequent material thereon shall have a relative compaction of ninety percent (90%) for a depth of six inches (6") as determined by ASTM Test Method No. 2922. The sub-grade shall be smooth and true to the required grade conforming to Alternate Section, Earthwork. Immediately prior to the placement of aggregate base, the compacted sub-grade shall be thoroughly moistened with water to the satisfaction of the Engineer. Ponded water shall not be permitted.

3.03 AGGREGATE BASE CONSTRUCTION

A. Aggregate Base shall be spread on a prepared sub-grade in conformance with the lines, grades and dimensions required in the Contract Documents. Aggregate Base shall be installed to the depths indicated on the plans or if not specifically shown on the plans. Aggregate Base shall be compacted to no less than ninety-five percent (95%) relative compaction. Immediately prior to placement of concrete, the Aggregate Base shall be thoroughly moistened to the satisfaction of the Engineer. Ponded water shall not be permitted.

B. Where existing concrete sections are to be replaced, the existing Aggregate Base may be reused subject to approval of the Engineer. Additional excavation and additional material may be required to bring the Aggregate Base to the required thickness.

3.04 FIXED FORMS

A. Forms shall be smooth on the side placed next to the concrete, and shall have a true smooth upper edge and shall be sufficiently rigid to withstand the pressure and tamping of fresh concrete without distortion. Timber forms shall be free from warping or deformation.

B. All forms shall be thoroughly cleaned and coated with form oil to prevent the concrete from adhering to them.

C. The depth of forms for back of curbs shall be equal to the depth of the curb. The depth of face forms for concrete curbs shall be equal to the full face height of the curb. Forms shall be set carefully to alignment and grade and shall be held rigidly in place by stakes, spreaders, or clamps, and shall be braced so that no displacement will occur during the working of the concrete. For other than short radius curves, timber forms shall be nominal two inch (2") stock.

D. All concrete placements shall be confined, and no neat (earth confined) concrete placement shall be allowed. Concrete placement against existing asphaltic concrete paving shall not be allowed unless approved by the Engineer.

3.05 PLACEMENT

A. All Portland Cement Concrete shall be used while fresh and before it has taken an initial set. Placement shall be in accordance with Section 90 of the Caltrans Standard Specifications unless otherwise provided in the Contract Documents. Re-tempering any partially hardened concrete with additional water or by vibration, shall not be permitted.

B. Concrete shall be placed continuously between joints and brought to the required grade and section as the work progresses. Sidewalk and top of curb sections shall slope towards the street at a cross slope of 0.25 inch per foot (2% maximum slope) unless otherwise specified in the Contract Documents or directed by the Engineer. Sections not complying with said cross slope shall be removed and reconstructed as directed by the Engineer. Concrete shall be consolidated by vibrating and/or tamping.

3.06 JOINTS (CURB & GUTTER)

A. Expansion joints shall be installed at each side of structures, at the ends of curb returns, and at locations specified in the Contract Documents. Weakened plane joints shall be constructed at ten feet (10') maximum intervals. Weakened plane joints shall be cut to a minimum depth of one inch (1") with a tool that leaves corners rounded and insures free

B. movement of drain water across the joint. Weakened plane joints shall have a minimum width of one-eighth inch (1/8") and shall not exceed three-eighths inch (3/8"). Weakened plane joints and score marks shall be installed when the concrete is still plastic. Saw cutting after the concrete sets will not be allowed unless specifically called for in the contract documents.

3.07 JOINTS (SIDEWALK)

A. Expansion joints shall be constructed at all returns and opposite expansion joints in adjacent curb. Where curb is not adjacent, expansion joints shall be constructed at intervals of sixty feet (60'), and at locations specified in the Contract Documents. Weakened plane joints shall be constructed at ten feet (10') maximum intervals and opposite weakened plane joints in adjacent curb. Joints shall be constructed at right angles to the line of the curb or radially on curves and curb returns and to the same depth and width as for curbs and gutter.

B. Score lines shall be constructed at five feet (5') intervals at right angles to the line of curb or radially for curves and curb returns. For sidewalk eight feet (8') or over in width, a score line parallel to the line of curb shall be constructed midway between back of curb and back of walk.

C. Score lines shall be made with a scoring tool that will make a rounded line of uniform maximum width and depth of three-eighths inch (3/8"). A score line parallel to the face of curb shall be constructed parallel to and six inches (6") from the face of curb.

3.08 CONTACT JOINTS

A. Contact Joints shall be used where concrete is to be poured adjacent to existing concrete or where cold joints are created due to breaks in the concrete pouring sequence. Reinforcing steel dowels are to be imbedded in holes drilled into the existing concrete using epoxy.

3.09 TOLERANCE

A. The top and face of curbs and gutter and the surface of sidewalks shall not vary more than one-fourth inch (1/4") from the edge of an eight feet (8') straight edge when placed against the surface, except at grade changes or curves. The flowline of gutters shall be built and finished to allow continuous flow of water and shall be tested with water prior to initial concrete set so that it does not stand more than one-fourth inch (1/4") deep at any location prior to final finishing. In no case will standing water be allowed in the flow line of the landing of a curb ramp.

3.10 FINISH

A. Fresh concrete shall be struck off and compacted until a layer of mortar has been brought to the surface. The surface shall be finished to grade and cross section with a float, troweled smooth with no rock pulls, and finished with a broom. The broom finish and texture of the concrete shall be a light to medium finish as approved by the Engineer. Concrete adjacent to expansion joints shall be finished with an edger tool. Brooming of sidewalk and top of curb shall be transverse to the line of traffic. Brooming of gutters shall be in the direction of flow. Finish of curb ramps shall be as indicated in the Contract Documents.

3.11 CURING

A. Curing of exposed concrete surfaces shall use curing compound in accordance with Section 90-7.07 of the Caltrans Standard Specifications and shall be applied in accordance with manufacturer's specifications. Water curing will not be allowed except with the approval of the Engineer.

3.12 SIDEWALK AND CURB LETTERING

A. Contractor’s Name

1. The Contractor shall stamp his name and the date of pour on the curb or sidewalk at intervals of approximately four hundred feet (400'), or as directed by the Engineer. The location is to be approved by the Engineer prior to stamping. The letters shall not be smaller than three-fourth inch (3/4") in height and sunk to a depth of not less than one-fourth inch (1/4").

B. Sewer Lateral Marks

1. The Contractor shall stamp a block letter "S" on face of curb at all points along the work where sewer laterals intersect the face of curb. The block letter "S" shall not be smaller than two inches (2") of height and indented to a depth of not less than one-fourth inch (1/4"). The letter "S" shall be spaced carefully and evenly so that the center point of the letter shall be equidistant from top of curb and flow line of gutter.

3.13 DRIVEWAYS

A. Driveways shall be constructed at locations indicated in the Contract Documents or as directed by the Engineer. If new driveways are to be constructed in the public right-of-way

where private driveways exist, the centerlines and width of both shall agree unless directed by the Engineer. The Contractor shall notify the Engineer before starting work.

3.14 SLIP FORM/EXTRUDED CURBS

A. Curb (Type B) and Curb and Gutter (Type A) sections of the Standard Detail (Concrete Median Curbs) may be placed using a slip form or an extrusion machine, except on structures, provided the finished curb is true to the required cross section, line and grade and the concrete is dense and has the required surface texture. Refer to Section 73-1.05B of the State Standard Specifications except as provided herein. The same requirements that are provided in this Subsection 4.0 above for subgrade preparation, joints, tolerance, finish, curing, lettering, etc. shall apply.

B. In advance of placing Type B curbs on existing pavement, steel dowels shall be inserted into holes drilled in the pavement and secured with epoxy as provided in the Contract Documents. If allowed by the Engineer, the curb may be attached to the pavement using epoxy conforming to 952.03 of the State Standard Specifications.

C. Extruded curbs to be constructed on epoxy shall be placed on the applied adhesive according to the manufacturer’s recommendation or not more than thirty (30) minutes after the start of mixing the two components, whichever is less, and shall be applied to the full width of the base of the curb and to the thickness recommended by the manufacturer or as directed by the Engineer.

3.15 SLIP FORM/EXTRUDED CURB, GUTTER AND SIDEWALK SECTIONS

A. Construction of sidewalk or curb and gutter or monolithic curb, gutter and sidewalk sections by either the slip form or extrusion method will only be permitted if provided in the Contract Documents or if allowed by the Engineer. The finished concrete must be true to the required cross section, line and grade and the concrete must be dense and have the required surface texture. The same requirements that are provided above in this Section 4.0 for subgrade preparation, joints, tolerance, finish, curing, lettering, etc., shall apply. Pours using the Slip Form/Extrusion processes shall stop at driveways, curb ramps, catch basins, utility boxes, etc. and as directed by the Engineer. Concrete at these locations shall be placed using fixed forms. Where pours are not continuous, a contact joint shall be constructed as indicated in this Section.

3.16 REPAIR OF CRACKS PRIOR TO ACCEPTANCE

A. Cracks developing in concrete work prior to it being accepted shall be repaired as directed by the Engineer, at the Contractor's expense, using the following method:

B. The sidewalk flag(s), curb, and gutter affected by cracking shall be sawed through along existing score marks, weakened plane or expansion joints surrounding the affected area, and as marked for replacement by the Engineer. On sidewalks with a centerline score mark, the sidewalk will be replaced to its full width (from back of walk to back of curb). The entire damaged sections shall be broken out and removed from the work. Prior to replacing the concrete, aggregate base shall be removed from under the edges of the adjacent concrete to provide space for the fresh concrete to "key" under them. Steel dowels, in the number and configuration acceptable to the Engineer, shall be placed using epoxy adhesive. The replacement concrete shall match the existing concrete in grade and texture and shall conform to this Section 5.0.

C. An alternative procedure may be used only if approved by the Engineer. In such cases, the cracks shall be filled with a concrete bonding agent, approved by the Engineer. The bonding agent shall be applied under pressure in order that full penetration of the crack is

insured. After setting, the filled cracks shall be stoned smooth so as to present a smooth unbroken surface.

D. No neat (earth confined) pours shall be allowed. Pours against existing asphalt pavement will be allowed only upon approval of the Engineer.

3.17 REPAIRS DURING GUARANTY PERIOD

The following procedures shall be used for the repair of cracks developing in concrete during the one-year guarantee.

A. The Contractor shall meet with the Engineer at the jobsite to determine the repairs to be made and to determine if it is required to obtain a permit from the City. The Engineer shall be notified to inspect the proposed work at the following stages:

1. Prior to the sawing and removal of the affected section B.
2. Prior to placing aggregate base.
3. After installation of forms for grade and alignment and prior to replacing concrete.
4. Prior to replacement of concrete.

B. All repairs shall be made as those done prior to acceptance (per 5.1 above).

C. All work shall be done in accordance with the Contract Documents and at no cost to the Campus.

END OF SECTION

SECTION 32 3113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes materials applicable for commercial/industrial and security chain link fence and gates.
   1. Galvanized steel coated chain link fabric
   2. Galvanized steel framework and fittings
   3. Gates: swing and cantilever slide
   4. Barbed wire

B. Related Requirements:
   1. Division 01 - General Requirements.
   2. 01 33 13 Certificates
   3. 01 33 23 Shop Drawings, product data
   4. 01 43 13 Manufacturers Qualifications
   5. 01 43 23 Installer Qualifications
   6. 01 45 00 Quality Control
   7. 01 65 00 Product Delivery Requirements
   8. 01 66 00 Product Storage and Handling Requirements
   9. 03 30 53 Miscellaneous Cast in Place Concrete

1.04 REFERENCE STANDARDS

A. ASTM A 121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire; 1999 (Reapproved 2004).

B. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2002.

C. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.

D. ASTM A 392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2003.

E. ASTM F552 Standard Terminology Relating to Chain Link Fencing

F. ASTM F 567 - Standard Practice for Installation of Chain-Link Fence; 2000.

G. ASTM F626 Specification for Fence Fittings

H. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot- Dip Galvanized Coatings

I. ASTM F900 Specification for Industrial and Commercial Swing Gates

J. ASTM F1043 Specification for Strength and Protective Coatings of Metal Industrial Chain Link Fence Framework

K. ASTM F 1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated

(Galvanized) Welded, for Fence Structures; 2004.

L. ASTM F1345 Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric

M. ASTM F2781 Standard Practice for Testing Forced Entry, Ballistic, and Low Impact Resistance of Security Fence Systems

N. CLFMI SFR 2445 Security Fence Recommendations

O. CLFMI CLF TPO211 Tested and Proven Performance of Security Grade Chain Link Fence Systems

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop drawings: Site plan showing layout of fence location with dimensions, location of gates and opening size, cleared area, elevation of fence and gates, details of attachments and footings.

C. Certifications: Manufacturer's material certifications in compliance with current ASTM specifications.

D. Domestic certifications: Material certifications, Made in U.S.A., Buy American Act or Buy America when required.

1.06 QUALITY ASSURANCE

A. Manufacturer: Company operating in the United States having U.S. manufacturing facility/facilities specializing in manufacturing chain link fence products with at least 5 years experience.

B. Fence contractor: Company with demonstrated successful experience installing similar projects and products in accordance with ASTM F567 and have at least 5 years experience.

1.07 TOLERANCES: Current published edition of ASTM specifications tolerances apply. ASTM specification tolerances supersede any conflicting tolerance.

1.08 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver products to site per contract requirements.

B. Storage: Store and protect products off the ground when required.

PART 2 PRODUCTS

2.01 CHAIN LINK FABRIC

A. Steel Chain Link Fabric 2 mesh, 6 gauge 8 feet high per ASTM A392.
1. Zinc-Coated Steel Fabric: ASTM A392 hot dipped galvanized before weaving.
2. Class 2 - 2.0 oz/ft² (610 g/m²) 6 gauge]
3. Standard fabric selvage for 2 in (50 mm) mesh 72 in. (1.8 m) high and over is knuckle finish at one end, twist at the other, K&T.

2.02 STEEL FENCE FRAMEWORK

A. Round steel pipe and rail: ASTM F1043 Group IA Heavy Industrial Fence Framework, schedule 40 galvanized pipe per ASTM F1083. Exterior hot dipped zinc coating minimum average 1.8 oz/ft², interior hot dipped zinc coating minimum average 1.8 oz/ft² Regular Grade.
   1. Line post: 2 inch OD.
   2. End, Corner, Pull post: 2.5 inch OD.
   3. Gate post: 4 inch OD.
   4. Top, brace, bottom and intermediate rails, 1.660 in. (42.2 mm) OD, 2.27 lb/ft [3.38 kg/m]

2.03 TENSION WIRE

A. Metallic Coated Steel Marcelled Tension Wire: 7 gauge (0.177 in.) (4.50 mm) marcelled wire complying with ASTM A824 Type II Zinc-Coated Class 5 - 2.0 oz/ft² (610 g/m²)

2.04 BARBED WIRE

A. Metallic Coated Steel Barbed Wire: Comply with ASTM A121, Design Number 12-4-5-14R, double 12-½ gauge (0.099 in.) (2.51 mm) twisted strand wire, with 4 point 14 gauge (0.080 in.) (2.03 mm) round barbs spaced 5 inches (127 mm) on center. Match coating type to that of the chain link fabric. Coating Type Z - Zinc-coated: Strand wire coating Type Z, Class 3, 0.80 oz/ft² (254 g/m²), barb coating 0.70 oz/ft² (215g/m²)

2.05 FITTINGS

A. Tension and Brace Bands: Galvanized pressed steel complying with ASTM F626, minimum steel thickness of 12 gauge (0.105 in.) (2.67 mm), minimum width of 3/4 in. (19 mm) and minimum zinc coating of 1.20 oz/ft² (366 g/m²). [Bands supplied with 3/8 in. (9.53 mm) galvanized steel carriage bolts]

B. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: In compliance to ASTM F626, pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz/ft² (366 g/m²).

C. Truss Rod Assembly: In compliance with ASTM F626, 3/8 in. (9.53 mm) diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft² (366 g/m²), assembly capable of withstanding a tension of 2,000 lbs. (970 kg).

D. Tension Bars: In compliance with ASTM F626. Galvanized steel one-piece length 2 in. (50 mm) less than the fabric height. Minimum zinc coating 1.2 oz. /ft² (366 g/m²). Bars for 2 in. (50 mm) and 1 ¾ in. (44 mm) mesh shall have a minimum cross section of 3/16 in. (4.8 mm) by 3/4 in. (19 mm).

E. Barbed Wire Arms: In compliance with ASTM F626, pressed steel galvanized after fabrication, minimum zinc coating of 1.20 oz. /ft² (366 g/m²), capable of supporting a vertical 250 lb (113 kg) load. Type II – three strand vertical arm.

F. Fork Latch: Gates shall be equipped with a heavy duty fork-type latch with lock keeper and lock keeper guide and as indicated on the plans.

2.06 TIE WIRE and HOG RINGS

A. Tie wire and hog rings per ASTM F626, Minimum zinc coating 1.20 oz/ft² (366 g/m²).

B. Wire ties 9 gauge (0.148 in.) (3.76 mm) galvanized steel preformed power-fastened.

C. Steel hog rings 9 gauge (0.148 in.) (3.76 mm) galvanized.

2.07 SWING GATES

A. Swing Gates: double opening 20 feet by 8 ft. high.

B. Galvanized steel welded fabrication in compliance with ASTM F900.

C. Gate frame members 1.900 in. OD (48.3 mm), ASTM F1043 Group IA F1083 schedule 40 pipe.

D. Frame members spaced no greater than 8 ft. (2440 mm) apart vertically and horizontally.

E. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A780.

F. Positive locking gate latch fabricated of 5/16 in. (7.9 mm) thick by 1 ¾" (44.45 mm) pressed steel galvanized after fabrication.

G. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges.

H. Match gate fabric to that of the fence system.

I. Gateposts 4 inch OD ASTM F1043 Group IA ASTM F1083 schedule 40 pipe.

2.08 CONCRETE

A. Concrete for post footings shall have a 28-day compressive strength of 2,500 psi. (17.2 MPa).

PART 3 EXECUTION

3.01 CLEARING FENCE LINE

A. The General Contractor shall clear and grade the site , ready for fencing.

3.02 FRAMEWORK INSTALLATION

A. Posts: Posts shall be set plumb in concrete footings in accordance with ASTM F567.

B. Gate latches minimum footing depth, 24 in. (609.6 mm).

C. Line posts minimum footing depth, 36 in. (914.4 mm) installed at intervals not exceeding 10 ft. (3.05 m) on center.

D. Gate posts minimum footing depth, 48 in. (1,219.2 mm).

E. Top of post concrete footing to be at grade crowned to shed water away from the post.

F. Top rail: When specified, install 21 ft. (6.4 m) lengths of rail continuous thru the line post or barb arm loop top. Splice rail using top rail sleeves minimum 6 in. (152 mm) long. The rail shall be secured to the terminal post by a brace band and rail end. Bottom rail or intermediate rail shall be field cut and secured to the line posts using boulevard bands or rail ends and brace bands.

G. Terminal posts: End, corner, pull and gate posts shall be braced and trussed for fence 6 ft. (1.8 m) and higher and for fences 5 ft. (1.5 m) in height not having a top rail. The horizontal brace rail and diagonal truss rod shall be installed in accordance with ASTM F567.

H. Tension wire: Shall be installed 4 in. (101.6 mm) up from the bottom of the fabric. Fences without top rail shall have a tension wire installed 4 in. (101.6 mm) down from the top of the fabric. Tension wire to be stretched taut, independently and prior to the fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to the chain link fabric with a 9 gauge hog rings 18 in. (457.2 mm) on center and to each line post with a tie wire.

3.03 CHAIN LINK FABRIC INSTALLATION

A. Chain Link Fabric: Install fabric to inside of the framework. Attach fabric to the terminal post by threading the tension bar through the fabric; secure the tension bar to the terminal post with tension bands and 5/16 in. (7.94 mm) carriage bolts spaced no greater than 12 inches (304.8 mm) on center.

B. Chain link fabric to be stretched taut free of sag. Fabric to be secured to the line post with tie wires spaced no greater than 12 inches (304.8 mm) on center and to rail spaced no greater than 18 inches (457.2 mm) on center. Secure fabric to the tension wire with hog rings spaced no greater than 18 inches (457.2 mm) apart.

C. Pre-formed 9 gauge galvanized steel power-fastened tie wire shall be wrapped 360 degrees around the post or rail and fabric picket, twist the two wire ends together three full turns per ASTM Excess wire shall be cut off and bent over to prevent injury.

D. The installed fabric shall have a ground clearance on no more than 2 inches (50 mm).

3.04 BARBED WIRE INSTALLATION

A. Barbed Wire: Stretched taut between terminal posts and secured in the slots provided on the line post barb arms. Attach each strand of barbed wire to the terminal post using a brace band.

B. Barb arm, Type, II

3.05 GATE INSTALLATION

A. Swing Gates: Installation of swing gates and gateposts in compliance with ASTM F567. Direction of swing shall be outward. Gates shall be plumb in the closed position having a bottom clearance of 3 in. (76 mm) grade permitting.

B. Hinge and latch offset opening space from the gate frame to the post shall be no greater than 3 in. (76 mm) in the closed position.

C. Double gate drop bar receivers shall beset in a concrete footing minimum 6 in. (152 mm) diameter 24 in. (609.6 mm) deep.

D. Gate leaf holdbacks shall be installed for all double gates.

3.06 NUTS AND BOLTS

A. Bolts: Carriage bolts used for fittings shall be installed with the head on the secure side of the fence. All bolts shall be peened over to prevent removal of the nut.

3.07 ELECTRICAL GROUNDING

A. Grounding: Grounding of the fence and gates is not the responsibility of the fence contractor and not included in the fencing scope of work for this contract.

3.08 CLEAN UP

A. Clean Up: The area of the fence line shall be left neat and free of any debris caused by the installation of the fence.

END OF SECTION

SECTION 32 80 00

IRRIGATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Landscape irrigation system work is shown on the Drawings including, but not necessarily limited to, the following:
   1. Automatic irrigation controls and systems.
   2. Line voltage connections to the irrigation controllers and low voltage control wiring from controllers to master valve, flow sensor, and remote control valves.

B. Work Included Under Other Sections:
   1. 120 Volt A.C. electrical stub-out for irrigation controller.
   2. Irrigation sleeves.

C. Related Requirements:
   1. Section 31 01 90 - Landscape and Site Maintenance
   2. Section 32 90 00 - Planting

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. D1785 - Standard Specifications for (PVC) Plastic Pipe, Schedules 40 and 80.
   2. D2241 - Standard Specifications for PVC Pressure-Rated Pipe (SDR Series).
   3. D2564 - Standard Specifications for Solvent Cements for (PVC) Plastic Pipe and Fittings.
   4. F2768 - Standard Specification for Modified Stub ACME Thread Joint with Elastomeric Seal in Plastic Piping Components.
   5. D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
   6. F512 - Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
   7. D2672 - Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.

B. National Sanitation Foundation (NSF), requirements for Seal of Approval.

C. Plastics Pipe Institute (PPI), recommendations for hydrostatic design stresses for PVC pipe.

D. State of California, Business and Transportation Agency, Department of Transportation (Caltrans) "Standard Specifications."

E. Permits and Fees: Contractor is responsible to obtain all required permits and pay all associated fees unless otherwise noted.

F. Irrigation Association/American Society of Irrigation Consultants, Landscape Irrigation Best Management Practices, 2014 edition.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Substitutions for specified products shall be submitted for approval in accordance with applicable specifications sections.

B. Submittal Procedures: Action and Informational Submittals shall be submitted in accordance with applicable specifications sections.

C. Coordination, Sequencing, and Scheduling:
   1. Contractor shall be solely responsible for coordinating, sequencing and scheduling work with applicable trades and subcontractors so as to ensure proper and timely installation of the irrigation system.
   2. The entire irrigation system shall be under full automatic operations for a period of two days prior to beginning of planting. Coordinate with Section 32 90 00 – Planting.

D. Permits and Fees: Contractor is responsible to obtain all required permits and pay all associated fees unless otherwise noted.

1.04 ACTION SUBMITTALS

A. Shop Drawings: A diagrammatic drawing of proposed mainline route and equipment locations for approval by the Owner's Representative. The Drawings may be marked and used for marking layout and equipment locations.

B. Product Data: Manufacturer's literature or cut sheets of products specified and to be incorporated into the irrigation system. Specific products being submitted shall be highlighted or shown on boxes on cut sheets to designate which items are being submitted. Submittals not marked appropriately will be rejected.

C. Materials List: Prior to installation, submit a materials list. Include manufacturer, model number, and description of all materials and equipment. List shall also include sealants, cements, lubricants and other proprietary items.

1.05 CLOSEOUT SUBMITTALS

A. Record Drawings as specified.

B. Maintenance equipment as specified.

C. Warranties and Guarantees

1.06 RECORD DOCUMENTS

A. Comply with applicable specifications sections for Project Record Documents.

B. Accurately record locations of all piping and equipment that varies from what is shown on the Drawings. Locations are to be clearly dimensioned horizontally to within 1 foot and vertically to within 0.5 feet from a hardscape edge or permanent site feature.
   1. The valve size, station number and gallons per minute shall be legible at each valve and shall match how the controller is wired.
   2. Additionally, each valve shall be annotated to describe which type of irrigation it is; rotor, rotator, spray, bubbler, drip tubing or other.
   3. Symbols for valves shall be annotated as: remote control valve (RCV), and quick coupler valve (QCV).

C. Contractor shall record and scan and submit PDF files of full size plan set of Record Drawings (As-builts Drawings) to the Owner's representative, and two sets of color coded plans shall be produced, one for placement at or within the irrigation controller cabinet reduced to 11" x 17", and one full size set for submittal to the Owner or stored at another location selected by the Owner's Representative.
   1. Both sets shall have all the irrigation valve zone lateral lines color-coded so as to readily distinguish between adjacent zones.
   2. The color-coded copies shall then be professionally laminated in minimum 5 mil clear plastic.

1.07 QUALITY ASSURANCE

A. Unless otherwise specified, install all materials in accordance with manufacturer's details, specifications and recommendations.

B. The Contractor shall be responsible to assure the irrigation installer personally or through an authorized and competent representative, supervises the work and retains the same supervisor on the job from commencement to completion.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store PVC pipe in a neat and orderly manner fully supported and protected from sunlight.

B. Equipment and materials shall be delivered, unloaded, and handled so as to protect from damage at all times.

1.09 FIELD CONDITIONS

A. PVC shall not be cemented during wet conditions at the discretion of the Owner's Representative.

B. Trench excavation and backfilling shall not be performed during excessively wet conditions at the discretion of the Owner's Representative.

C. Water Supply: Connections to, or the installation of, the water supply shall be at the locations shown on the Drawings. Minor changes caused by actual site conditions shall be made at no additional expense to Owner.

D. Discrepancies: In the event of discrepancy, immediately notify the Owner's Representative. Do not proceed with installation or irrigation components or system in areas of discrepancy until discrepancies have been resolved.

1.10 MAINTENANCE EQUIPMENT

A. Turn-over Materials: Provide 1 each of the following to the Owner's Representative:
   1. One quick coupler attachment key equipped with standard thread hose bib for each 5 quick couplers installed on the project.
   2. One key for locking quick coupler covers for each 5 quick coupler valves installed on the project..

1.11 GUARANTY

A. Contractor: Provide Owner with a separate written guaranty for the entire irrigation system against defects in installation, workmanship and equipment, for a period of 1 year from the date of Final Acceptance.

B. Contractor shall make necessary repairs to the system as well as to other work affected by defects in the system during guaranty period. Repairs shall be made at the Contractor's sole expense.

PART 2 - PRODUCTS

2.01 GENERAL

A. Use only new materials of brands shown on Drawings, specified herein or as acceptable to the Owner's Representative.

2.02 PIPE

A. General:
   1. Plastic pipe shall be extruded of an improved PVC virgin pipe compound in accordance with ASTM D2672, ASTM D2241 or ASTM D1785.
   2. Pipe shall be marked continuously with manufacturer's name, nominal pipe size, schedule or class, PVC type and grade, National Sanitation Foundation approval, Commercial Standards designation, and date of extrusion.

B. Plastic Pipe: Polyvinyl chloride PVC (Type I) 1120.
   1. Intermittent-Pressure Lateral Piping: 1120-Schedule 40 PVC plastic pipe with Schedule 40, Type 1, Grade 1, PVC solvent weld fittings.
   2. Constant-Pressure Mainline Piping 2 inches and Smaller: Schedule 40 with solvent weld fittings.
   3. Constant-Pressure Mainline Piping 2-1/2 Inches and larger: Class 200 SDR-21 or 2-1/2" to 3" Class 315 SDR-14, if requested by Owner, or C900 Class 200 DR-14, if the system is using recycled or well water.
   4. Constant-pressure mainline piping 4 inches and larger shall be Class 200 PVC ring-tite with IPS ductile iron fittings and mechanical restraints at all bell fittings and fittings at changes in direction.
   5. Constant-pressure mainline piping 3 inches and larger on systems with booster pumps shall be Class 200 PVC ring-tite with IPS ductile iron fittings and mechanical restraints at all bell fittings and fittings at changes in direction.
   6. If the system is operated with recycled water, PVC pipe shall be "Purple Pipe."

C. Recycled water piping, other than PVC piping with solvent welded joints, shall be protected against movement with thrust blocks or mechanical restraints.

2.03 FITTINGS

A. PVC Fittings: Polyvinyl chloride (Type I) plastic 1120, Schedule 40 or Schedule 80 where noted on the Drawings.

B. PVC Nipples: Polyvinyl chloride (Type I) plastic 1120, Schedule 80.

C. PVC fittings used with UVR pipe shall be Schedule 40 UVR PVC type.

2.04 SWING JOINTS

A. Swing joints for Rotator and pop-up heads shall be as detailed on the Drawings.

B. Swing Joints for rotors shall be by LASCO Fittings, Inc. with ASTM F2768 Standard for Swing Joint ACME Threads, or equal.

2.05 VALVES AND SENSORS

A. General:
   1. Each valve shall be installed with unions before and after the valve.
   2. Control Valves shall be labeled with tags denoting the associated controllers and station numbers.

3. Gate Valves and Ball Valves:
   a. Valves shall have a minimum working pressure of not less than 150 psi and shall conform to AWWA standards.
   b. Provide purple tags on all valves if system is designed for recycled water.

B. Master Valve: As specified on Drawings.

C. Flow Sensors: As specified on Drawings.
1. Flow Sensor wiring conduit shall be Schedule 80 grey PVC electrical conduit complying with ASTM F512, size as required.

D. Gate Valves and Ball Valves: As specified on Drawings.

E. Remote Control Valves: As specified on Drawings.

F. Quick Coupling Valves: As specified on Drawings. Provide purple lid if system is designed for recycled water.

2.06 PLASTIC VALVE BOXES

A. General:
1. Color of plastic boxes shall be green, unless the irrigation system is designed for recycled water, in which case boxes shall be purple.
2. If black or green valve boxes are required by the Owner for use on recycled water systems, the lids shall be purple or shall have a warning label or nameplate permanently molded into or attached onto the lid with rivets, screws, or bolts.
3. Warning labels shall be as specified on Drawings.
4. Valve boxes shall have locking or bolt down type lids.
5. Markings on valve box covers shall be "heat branded" onto the cover in 1-inch high letters.
6. Manufacturer: Carson Industries as specified and the basis of design, Applied Engineering Inc., NDS, Christy, or equal.

B. Master Valve, Rectangular:
1. Valves 1 inch and 1-1/2 inches: Model equivalent to Carson 1419-12 with 1419-T locking lid.
2. Valves 2 inches and larger: Model equivalent to Carson 1730-18 with 1730T locking lid.
3. Boxes shall be labeled as "Irrigation - MV" on lid.

C. Flow Sensor, Rectangular:
1. Sensors up to 4 inches: Model equivalent to Carson 1419-12 with 1419-T locking lid.
2. Boxes shall be labeled as "Irrigation - FS" on lid.

D. Gate Valves and Ball Valves, Round:
1. Model equivalent to Carson 910-10 with 910-T locking lid.
2. Boxes shall be labeled as “Irrigation – GV” on lid.

E. Remote Control Valves, Rectangular:
1. Valves 1 inch and 1-1/2 inches: Model equivalent to Carson 1419-12 with 1419-T locking lid.
2. Valves 2 inches and larger: Model equivalent to Carson 1730-12 with 1730-T locking lid.
3. Boxes shall be labeled as “Irrigation – RCV” on lid.

F. Quick Coupling Valves, Round:
1. Model equivalent to Carson 910-10 with 910-T locking lid.
2. Boxes shall be labeled as “Irrigation – QC” on lid.

G. Valve Boxes shall have locking or bolt down type lids. Approved box manufactures as equals: Applied Engineering Inc., NDS, Christy, Carson Industries, or equal.

2.07 ELECTRICAL

A. General:
1. Electrical equipment shall be NEMA Type 3, waterproofed for exterior installations.
2. Electrical work shall conform to local codes and ordinances.
3. Remote control wire shall be UL rated for direct burial.
4. Where two or more controllers are used, the control wires shall be a different color for each controller. These colors shall be noted on the "Record Drawings" placed in the controller cabinet.

B. Flow Sensor Wiring:
1. As per manufacturer's details and recommendations.
2. Flow Sensor conductors shall be installed in 1" Schedule 80 electrical conduit from controller to the Flow Sensor valve box.
3. Control wires from controller to flow sensor: 2 #14-gauge (AWG) wire, not to exceed 2,000 feet.
4. Splice connectors: 3M DBR-Y6 splice connectors, 3M Scotchcast #3570G-N Connector seal packs, or Spears DS-100 connectors with DS-300 sealant.

C. Low Voltage Control Valve Wiring:
1. Conductors:
a. Control Wires: Type UF, 14-gauge wire. Insulating jacket color shall be red.
b. Common Wires: Type UF, 12-gauge wire. Insulating jacket color shall be white.
c. Spare Control Wires: Type UF, 14-gauge wire, insulating jacket color shall be blue.
d. Spare Common Wire: Type UF, 12-gauge wire. Insulating jacket color shall be green.
2. Splice connectors: 3M DBR-Y6 splice connectors, 3M Scotchcast #3570G-N Connector seal packs, or Spears DS-100 connectors with DS-300 sealant.

2.08 CONNECTING COMPOUNDS

A. Primer: I Weld-On "P-70" Primer by IPS Corporation.

B. Cement: Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.
1. Pipe Diameter up to 6 Inches: Weld-On #705 by IPS Corporation, Low VOC PVC solvent cement for Class 200 PVC or schedule 40 PVC.
2. Pipe Diameter Larger than 6 Inches and Schedule 80 PVC: Weld-On #711 by IPS Corporation, Low VOC PVC solvent cement.
3. Flexible PVC to Rigid PVC Connections: Weld-On #795 by IPS Corporation, Low VOC PVC solvent cement.

2.09 TREE AND SHRUB BUBBLERS

A. Bubbler Nozzle Assemblies: As specified on the Drawings.

B. Install bubblers with purple caps if system is designed for recycled water.

2.10 ADDITIONAL MATERIALS

A. Tape:
1. General:
a. On-site buried recycled water piping shall be identified by warning tape with a minimum width of 3 inches reading "caution – recycled water" (in black or white lettering on purple background). Tape shall run continuously on top of main line piping and shall be attached to

piping with plastic tape banded around the warning tape and the pipe every 5 feet on center.

2. Pipe Detection Tape: 3-inch-wide, detectable type; “Terra Tape” "Sentry Line Detectable” from Reef Industries, Inc., 713.507.4251; or equal.
   a. Text: "Caution Water Line Buried Below."

B. Tracer Wire: Polyethylene insulated, copperclad steel; “SoloShot XTreme Tracer Wire” by Copperhead Industries, LLC. 877-726-5644, or equal.

C. Sleeves: Class 200 PVC. Install sleeves in locations and at the depths shown on the Drawings. Sleeves shall extend a minimum of 6 inches past the edge of the above hard surface for ease of location.

D. Teflon Tape: Variety commonly used for wrapping threaded connections.

E. Valve Tags: Plastic pre-labeled station tags.

F. Recycled Valve Tags: Plastic pre-labeled Purple warning tags.

G. Drain Rock: 3/4-inch wash drain rock complying with requirement specified in Section 32 11 00 – Base Courses.

H. Recycled valves including. isolation valves, irrigation remote control valves, quick coupling valves, and flow sensors shall be tagged using plastic pre-labeled Purple warning tags.

I. Recycled water advisory signs shall be in accordance with Owner’s standard details and shall be posted at locations shown on the approved irrigation drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to starting work, test and verify that water pressure levels meet the requirements specified on the Drawings. Notify the Owner’s Representative immediately of any discrepancies.

B. Irrigation Drawings are diagrammatic. Main lines and lateral lines shown parallel in the Drawings may be placed in a common trench, provided that a minimum horizontal distance of 3 inches is maintained between buried lines, as per Drawings.

C. Sprinkler heads are shown schematically. Suspected discrepancies in coverage or sizes of areas to be irrigated shall be brought to the attention of the Owner’s Representative prior to installation. Contractor shall re-direct work to avoid delay while awaiting resolution.

3.02 PREPARATION

A. Contractor shall make provisions and take necessary precautions to protect existing and completed work or features.

B. Layout:
   1. Prior to installation, the Contractor shall stake out all pressure supply lines, routing and location of backflow preventer, all valves, sprinkler heads, bubblers, drip tubing, and automatic controller for review by the Owner’s Representative.

2. Layout irrigation system and make minor adjustments required due to differences between site and Drawings. Where piping is shown on Drawings under paved areas, but running parallel and adjacent to planted areas, install the piping in the planted areas.

3.03 TRENCHING

A. Excavate trenches with vertical walls, uniform bottom, free of deleterious materials, and wide enough for pipes to lay side by side, fully supported on trench bedding. There shall be a minimum 3-inch clearance between all pipes.
   1. No lines shall be installed parallel to and directly over another line.
   2. When lines must cross, the angle shall be forty-five to ninety degrees, and a minimum of three inch (3") vertical clearance shall be maintained.

B. Provide minimum coverage depths as follows:
   1. Mainline: 24 inches in landscape areas, 30 inches in sleeves under paving.
   2. Lateral Lines: 18 inches in landscape areas, 30 inches in sleeves under paving.

C. Hydraulic driving methods shall not be used under paved surfaces.

3.04 PIPE INSTALLATION

A. Comply with manufacturer's instructions as applicable.

B. Rubber Ring Seal Joint:
   1. Use factory-made male end or prepare field-cut male end to exact specifications of factory-made end.
   2. Carefully clean bell or coupling and insert rubber ring without lubricant. Position ring carefully according to manufacturer's specifications.
   3. Lubricate male end according to manufacturer's instructions and insert male end to specified depth. Use hands only when inserting PVC pipe.

C. Thrust Blocks:
   1. Thrust blocks shall be provided on 3 inch and 4-inch main lines where specified and as necessary to resist system pressure on, and pipe movement of, pressurized lines and fittings. Thrust blocks shall be concrete and the size shall be based on an average soil safe bearing load of 3,000 pounds per square foot.
   2. Form thrust blocks in such a manner such that concrete comes in contact only with the fittings, not over the fitting joint. Thrust blocks shall be between solid soil undisturbed and the fitting.
   3. Install thrust blocks as shown in Drawings and as described above.
   4. Main lines of 3 inches and 4 inches with operating pressures of 85 psi or more, and systems with a booster pump, shall have mechanical restraints at all fittings and changes of flow direction.
   5. Main lines 6 inches and larger shall have ductile iron fittings with joint restraints installed at all couplings and changes in flow direction.

D. Solvent Welded Joints:
   1. Assemble above ground where possible.
   2. Cut square, ream, and thoroughly clean shavings and burs from pipe ends.
   3. Make joint using specified primer and cement, continuously wiping off excess.
   4. Allow 60 minutes of set-up time before handling and 24 hours curing before applying water pressure.

E. Threaded Joints:
   1. Use Teflon tape on all pressurized, threaded plastic to plastic and plastic to metal joints.
   2. Hand tighten and use only light strap-type friction wrench pressure to complete.

F. Snake pipe to provide a minimum of 1 additional foot for each 100 feet of pipe to allow for expansion and contraction.

G. Pipe shall be installed as specified and generally as shown in Drawings.

H. On-site buried recycled water piping shall be identified by using purple-colored PVC pipe with continuous wording: "caution – recycled water" printed on opposite sides of the pipe; pipe shall be laid with wording facing upwards.

I. Cap or plug pipe openings as soon as pipes have been installed to prevent intrusions of debris.

J. Sleeves:
1. Install pipe sleeves where necessary, where shown and at all points where pipes pass through concrete or masonry. In footings, install sleeving that allows 1-inch minimum clearance around pipes.
2. Each end of sleeve shall extend a minimum of 6 inches beyond edge of paving or structure above. Provide removable non-decaying plug or cap at each end of sleeve, to prevent earth from entering pipe.

K. Thoroughly flush system prior to installing valves, screens and nozzles.

L. Install pipe detection tape and tracer wire above mainline.

3.05 EQUIPMENT AND INSTALLATION

A. Reduced Pressure Backflow Prevention Device: Install in accordance with local codes and as shown on the Drawings.

B. Master Valve and Flow Sensors:
1. Install as shown in Drawings.
2. Valve boxes shall be set plumb, flush, and square with adjacent structures.
3. Valves shall be installed in valve boxes to provide 2-inch clearance between the highest point of the valve and the bottom of the valve box lid.
4. Install valve tags in an acceptable manner indicating valve station and controller number.
5. Provide 12-inch minimum separation when valve boxes are grouped together, and align in a straight, parallel, even, and orderly manner.
6. Locate all boxes a minimum of 10 feet from striping of any field of play.
7. Locate valves in shrub/ground cover areas whenever possible.

C. Gate Valves and Ball Valves:
1. Install as shown on the Drawings.
2. Valves shall be installed in valve boxes to provide a minimum of 2-inch clearance between the highest point of the valve and the bottom of the valve box lid.
3. Valves shall not be installed in any area that is within the athletic field of play. All valves shall be located within valve boxes set 12 inches from fencing or edge bands as shown.
4. Locate all boxes a minimum of 10 feet from striping of any field of play.

D. Remote Control Valves:
1. Install as shown in Drawings.
2. Valve boxes shall be set plumb, flush, and square with adjacent structures.
3. Valves shall be installed in valve boxes to provide 2-inch clearance between the highest point of the valve and the bottom of the valve box lid.
4. Install valve tags in an acceptable manner indicating valve station and controller number.
5. Provide 12-inch minimum separation when valve boxes are grouped together, and align in a straight, parallel, even, and orderly manner.

6. Locate all boxes a minimum of 10 feet from striping of any field of play.
7. Locate valves in shrub/ground cover areas whenever possible.

E. Quick Coupler Valves:
1. Install as shown on the Drawings.
2. Quick coupling valves shall be installed in valve boxes to provide 2-inch clearance between the highest point of the valve cover and the bottom of the valve box lid.
3. Locate all boxes a minimum of 10 feet from striping of any field of play.
4. Quick couplers in synthetic fields shall be located against synthetic turf edgeband and curbs.

F. Control Wire:
1. Install control wire along main line, or as shown in Drawings.
2. Connect control wires to controller in sequential arrangement according to identification number in the Drawings. Label each controller station with permanent non-fading labels indicating valve identification number and controlled.
3. Bundle multiple wires with tape or ties at 20-foot intervals maximum. Do not tape wires in sleeves.
4. Make all splices in control valve boxes using only specified connectors.
5. Provide 36-inch wire coil at each remote control valve and at all mainline directional changes.
6. Install 2 spare control wires and one looped spare common wire to run by, and loop into, every remote control valve box of system. Terminate wires inside controller enclosure unconnected and clearly labeled as extra.
7. All wiring under paving shall be installed in a PVC pipe sleeve large enough to allow withdrawal and insertion of individual proposed wires and room for 12 additional wires.
8. Control wire under 2,000 feet in length shall be 14 gauge.
9. If control wire run is over 2,000 feet, shall be 12 gauge.

G. Tree Bubbler Assemblies:
1. Install in perforated pipe sump as shown on the Drawings.
2. Coordinate installation with planting operations to ensure timely and proper placement of heads.

H. Shrub Bubbler Assemblies
1. Install as shown on the Drawings.

3.06 FIELD QUALITY CONTROL

A. General:
1. Notify Owner's Representative for the following reviews, with minimum 2 working days' notice:
   a. Pressure testing mains prior to installing heads.
   b. Coverage test prior to planting turf shrubs and or groundcover.
   c. Pre-maintenance observation prior to acceptance of installed irrigation system.
   d. Final observation prior to release of project to Owner.
2. Contractor shall provide all equipment and personnel required to conduct tests.
3. Provide up-to-date Project Record Drawings at each review.
4. If Owner's Representative is called out for review prior to the system being ready as specified, the contractor shall be back charged for the full cost of the review time, report, and travel.

B. Pressure Tests:
1. Testing shall occur with trenches open. Small amounts of backfill between fittings shall be allowed to prevent pipe displacement. All fittings shall be visible prior to testing.
2. Test all pressure supply lines under a minimum hydrostatic pressure of 125 psi. Pipe shall hold pressure for a period of 6 consecutive hours with no more than 5 psi loss in order to pass test.
3. Lateral lines shall be tested under full line pressure for a period of 1 hour prior to backfilling. Cap all heads and center load pipe between fittings prior to testing.
4. Correct all deficiencies revealed by tests to the satisfaction of the Owner's Representative.

C. System Flushing:
   1. After lateral lines, swing joints and sprinkler heads are in place and connected, and prior to installation of sprinkler nozzles, thoroughly flush all lines with water to completely clean lines of debris.
   2. Install sprinkler filters and nozzles only after lines have been flushed to the satisfaction of the Owner's Representative.

3.07 BACKFILLING

A. General:
   1. Backfill only after specified tests have been performed and accepted.
   2. Clean trenches of debris and deleterious material before backfilling.
   3. Backfill as shown on the Drawings with native material granular in nature and free from deleterious material rocks and clods 2" or larger.
   4. Install pipe detection tape over entire run of mainline as shown in Drawings.
   5. Compact trenching to 95 percent relative density under pavement and 85 percent relative density within planting areas.
   6. Dress off and compact trench surfaces with finish grade in a manner to ensure no settling of trenches will occur. If settling occurs, contractor is to bring in additional topsoil, recompact and grade to be flush with adjacent finish grade.
   7. Comply with additional requirements specified in Section 31 23 00 – Excavation and Fill.

3.08 ADJUSTING

A. Adjust and balance system to eliminate overspray, fogging or misting and as directed by Owner's Representative.

3.09 DEMONSTRATION

A. Instruct Owner's personnel in complete and proper operation and maintenance of system prior to Final Acceptance.

3.10 MAINTENANCE

A. Contractor shall service and maintain irrigation system during specified Landscape Maintenance Period as specified in Section 31 01 90 - Landscape and Site Maintenance.

B. The entire irrigation system shall be under fully accepted automatic operations for a period of 2 days prior to commencement of planting.

C. Final Acceptance and start of guaranty period shall occur no later than the end of the specified Landscape Maintenance Period.

3.11 FINAL REVIEW

A. Provide Owner's Representative with Record Documents and other specified closeout submittals prior to Final Review.

END OF SECTION

SECTION 32 90 00

PLANTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Landscaping as shown on the Drawings including, but not be limited to the following:
   1. Soil preparation.
   2. Fine grading of landscape areas.
   3. Plant material.
   4. Landscape Maintenance Period.

B. Related Requirements:
   1. Section 31 01 90 - Landscape and Site Maintenance.
   2. Section 32 80 00 – Irrigation.

1.02 REFERENCES

A. American Joint Committee on Horticulture Nomenclature (AJCHN): Standardized Plant Names.

B. American Association of Nurserymen, Inc. (AAN): American Standard for Nursery Stock.

C. Sunset Western Garden Book, Lane Publishing Company.

D. Agricultural Code of California.

E. State of California, Business and Transportation Agency, Department of Transportation (Caltrans) "Standard Specifications."

1.03 ADMINISTRATIVE REQUIREMENTS

A. Submittal Procedures: Action and Informational Submittals shall be submitted in accordance with applicable specifications sections.

B. Coordination:
   1. Irrigation and drainage systems shall be inspected and tested before start of any Work of this Section. Before covering subsurface drains and any subsurface drainage weeps, Contractor shall inspect and be responsible for their performance.

1.04 ACTION SUBMITTALS

A. Plant Materials and Products:
   1. Thirty days prior to planting, submit 4 copies of documentation that plants specified have been ordered. Include names and addresses of suppliers.
   2. Substitutions: If substitutions are required, they shall be brought to the attention of the Owner's Representative, at time of submittal. Refer to Section 01 25 00 – Substitution Procedures for additional requirements.

B. Product Data:
   1. Manufacturer's descriptive literature for products proposed for use.
   2. Certified chemical analysis of the following:
      a. Fertilizers.

b. Herbicides.

C. Samples: Submit 4 samples of the following in minimum 1-quart size "zip-lock" plastic bag:
1. Soil amendment. Include current evaluation and sieve analysis.
2. Bark mulch top dress.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Perform work in accordance with all applicable laws, codes, and regulation required by authorities having jurisdiction over such work and provide for all review and permits required by Federal, State, and local authorities in furnishing, transporting, and installing materials.
2. Certificates of review required by law for transportation shall accompany invoice for each shipment of plants. File copies of certificates with the Owner's Representative after acceptance of material. Review by Federal or State governments at place of growth does not preclude rejection of plants at project site.
3. Control of Work: Comply with Section 5 of the Standard Specifications.
4. Control of Materials: Comply with Section 6 of the Standard Specifications.

B. Contractor shall employ on-site supervisor at all times during execution of the planting. Supervisor shall be thoroughly familiar and experienced with the materials and products being installed and proper methods of their installation. Notify the Owner's Representative immediately of changes in supervisory personnel.

C. Products and materials shall be new, first quality, and acceptable to the Owner's Representative.

D. Tree, Shrubs and Plants: Provide trees, shrubs and plants of quantity, size, genus, species and variety shown and scheduled for landscape work and complying with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock." Provide healthy, vigorous stock, grown in a recognized nursery in accordance with good horticultural practice and free of disease, insects, larvae, and other defects such as girdling or bound roots, knots, sunscald, injuries, abrasions, and disfigurement.

E. Analysis and Standards: Package standard products with manufacturers certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

F. Quality Review: The Owner's Representative will review trees and shrubs before planting for compliance with specified requirements for genus, species, variety, size and quantity. Owner's Representative retains right to further review trees and shrubs for size and condition of root systems, trunks, stems branches or structure, buds, and other required features, and to disqualify unsatisfactory or defective material at any time during the progress of work. Remove disqualified trees or shrubs immediately from project site and replace with materials acceptable to Owner's Representative.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General:
1. Ship plant material and seed with certificates of inspection required by governing authorities. Comply with regulations applicable to plant materials.
2. Handle and store all products of this Section in such a manner as to protect them from damage at all times.
3. Storage of products on-site shall be coordinated by the contractor in an orderly manner so as not to unnecessarily impede the work or reasonable use of project site.

B. Plants:

1. Delivery: Coordinate with Owner's Representative. Provide proper identification for landscape labor force and vehicles at all times while on site.
2. Storage: Coordinate with Owner's Representative. Provide exposure as required by plant variety and provide wind protection for all plants. Water regularly to maintain thorough moisture in root zone. Temporary, automatic irrigation system will be required at discretion of Owner's Representative if extended storage period becomes necessary. Protect dark colored plant containers from direct exposure to the sun.
3. Labeling: At least one plant of each variety or type shall be legibly labeled at all times clearly indicating correct plant name as indicated on Drawings. Labels shall be durable with waterproof ink.

C. Fertilizers:
1. Deliver in original, unopened containers with original labels intact and legible which state the guaranteed chemical analysis.
2. Fertilizer, lime, soil sterilant, and all other potentially toxic products shall not be stored with any other landscape materials.

D. Bulk Material:
1. Coordinate delivery and storage of bulk material with Owner's Representative.
2. Confine materials to neat piles in areas acceptable to the Owner's Representative.

1.07 FIELD CONDITIONS

A. Planting operations shall not be conducted under the following conditions, subject to the discretion of the Owner's Representative:
1. Freezing weather.
2. Excessive heat.
3. High winds.
4. Excessively wet conditions.

1.08 WARRANTY

A. Contractor shall warrant work executed and all materials provided or used under this Section shall be free of defects and poor workmanship for a period of 1 year after Final Acceptance.

B. Contractor wall warrant plant materials shall be in a healthy and thriving condition 1 year after Final Acceptance, unless it can be proven that the unhealthy or non-thriving material is due to causes other than the Contractor's materials or workmanship.
1. Replace dead plants and plants not in vigorous condition immediately upon notification by Owner's Representative during Warranty Period.
2. Replaced plants shall be subsequently guaranteed by the Contractor for an additional year following date of replacement.
3. Repair defective materials and work shall be acceptable to the Owner's Representative.

1.09 MAINTENANCE PERIOD

A. Refer to Section 31 01 90 - Landscape and Site Maintenance for information.

PART 2 - PRODUCTS

2.01 TOPSOIL

A. Topsoil shall be clean on-site material that has been previously stripped from the top 4 inches of grade after initial 2-inch stripping of organics. Acceptable topsoil shall be free from rocks, stones, rubble, and clay clods over 2 inches in diameter, roots, toxins, and any other deleterious materials.

B. Imported topsoil shall have an agricultural suitability test by a qualified soils laboratory, dated within 30 days of purchase.
   1. Import topsoil proposed for use shall be submitted to the Owner's Representative for review and acceptance prior to delivery to the Project site.
   2. Submit samples and current soil fertility and structure analyses in the quantity specified.

2.02 FERTILIZERS

A. General:
   1. Fertilizers shall be of an acceptable brand with a guaranteed chemical analysis as required by USDA regulations.
   2. Fertilizers shall be dry and (except plant tabs) free flowing.

B. Pre-Plant Fertilizer: Shall be of the following chemical analysis:

Nitrogen:	6 percent.
Phosphoric Acid:	20 percent
Soluble Potash:	20 percent

C. Post-Plant Fertilizer: Shall be of the following chemical analysis:

Nitrogen:	16 percent
Phosphoric Acid:	6 percent
Soluble Potash:	8 percent

D. Plant Tabs: 7-gram tabs designed for 12-month slow release with the following chemical analysis by weight; "Gro-Power" or equal:

Nitrogen:	12 percent
Phosphoric Acid:	8 percent
Soluble Potash:	8 percent
Humus:	20 percent
Humic Acid:	4 percent
Sulfur:	3.5 percent
Iron:	2 percent
Micronutrients	

2.03 SOIL ADDITIVES

A. Soil Amendments: Organic Humus Compost
   1. Fully composted aerobic humus compost without presence of decomposition products. The organic matter content shall be at least 50% on a dry weight basis. Humus material shall have an acid-soluble ash content of no less than 6% and no more than 20%.
   2. The pH of the material shall be between 6% and 7.5%.
   3. The salt content shall be less than 10 millimho/cm @ 25° C in a saturated paste extract.
   4. Boron content of the saturated extract shall be less than 1.0 parts per million.
   5. Silicon content (acid-insoluble ash) shall be less than 50%.
   6. Calcium carbonate shall not be present if to be applied on alkaline soils.

7. Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, peat mosses etc. low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
8. Composted wood products are conditionally acceptable [stable humus must be present]. Wood based products are not acceptable which are based on red wood or cedar.
9. Sludge-based materials are not acceptable.
10. Carbon:nitrogen ratio is less than 25:1.
11. The compost shall be aerobic without malodorous presence of decomposition products
12. The maximum particle size shall be 0.5 inch, 80% or more shall pass a No. 4 screen for soil amending.
13. Maximum total permissible pollutant concentrations in amendment in parts per million on a dry weight basis:

Arsenic	20	Lead	200	Silver	10
Cadmium	15	Mercury	10	Vanadium	500
Chromium	300	Molybdenum	20	Zinc	200
Cobalt	50	Nickel	100		
Copper	100	Selenium	50		

14. Soil Amendments for consideration are listed below:
    a. Soil Plus;
    b. SBI;
    c. Grab N' Grow
    d. Wheeler Zamaroni

    Soil amendment submittal shall include sieve analysis as well as an agronomic soil analysis using a saturation extraction test. prepared by a qualified soil lab. Upon direction of owner's representative, contractor to provide, at contractor's sole cost, updated testing results for review and approval that are dated within 1 month of submittal date and prior to delivery of product to site.

B. Soil Conditioner: 4 percent sulfur; "Gro-Power Plus (5-3-1) by Gro-Power Inc., 800-473-1307, or equal.

C. Soil Sulphur: Agricultural grade, 99 percent pure, pelletized orgranular form, not powdered.

D. Iron Sulphate: Non-staining iron with micro-nutrients, soil penetrant, trace minerals, and humic acids; "Gro-Power Premium Green" by Gro-Power Inc., 800-473-1307, or equal.

2.04 MULCH TOP DRESS

A. Material: Medium-sized, 3/4 inch to 2 inches, decorative chipped wood, homogenous in appearance, free of deleterious and inorganic material, sticks, shredded, stringy, and fibrous materials; "Golden Nuggets" from Sun Up, 800-222-255; "MBC Red" from My Bark Company, Inc., 209-786-4042; or equal.

2.05 PLANTS

A. General:
    1. Plants shall conform to the species and minimum sizes shown on the Drawings.
    2. Quantities shown on the Drawings are for the Contractors convenience only. Contractor shall provide plant material to fulfill the intent of the Planting Plan at the discretion of the Owner's Representative.

B. Condition: Plants shall conform to the following minimum requirements:
    1. Nursery grown unless otherwise specified.
    2. Supplied in appropriate container, balled and burlapped, or bare root as specified on Drawings.

2.06 HERBICIDES

A. Pre-Emergent: "Ronstar-G" pelletized, "Surflan" liquid, or equal.

B. Other Herbicides: Submit for review and accepted by Owner's Representative prior to use.

2.07 ADDITIONAL MATERIALS

A. Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of plants.

B. General: Products and materials shall be new, first quality as acceptable to the Owner's Representative.

C. Tree Stakes and Ties: As shown and specified on the Drawings.

D. Weed Barrier: "Pro Weed Barrier" Model 24003080 DeWitt Co., Sikeston MO, 800-888-9669, or equal.
   1. Roll Size: 12 feet by 250 feet.
   2. Anchorage: 8 inch jute staples.

PART 3 - EXECUTION

3.01 TOPSOIL INSTALLATION

A. Subgrade soil shall be cut or filled to the depth required such that after placement of required amount of topsoil and specified preparation procedures have been accomplished, specified finish grades will be attained.

B. Subgrade soil shall be cross-ripped as specified.

C. Planting areas shall contain a minimum of 6 inches of acceptable topsoil applied as applicable and where required. Only previously accepted topsoil shall be installed.

D. Refer to Section 31 20 00 – Earth Moving for rough grading information.

3.02 PREPARATION

A. Make provisions and take necessary precautions to protect existing and new improvements from damage during execution of planting work.

B. Initial Preparations:
   1. Prior to beginning of planting, thoroughly cross-rip, with second rip shall be performed at 90 degrees to first rip, planting area soil to a depth of twelve 12 inches.
   2. Remove all rocks, sticks, clods, debris, and other deleterious materials over one-half (1/2) inch in diameter from top 6 inches of soil.
   3. Float, rake, and roll all planting areas as necessary to establish smooth, clean, non-yielding planting beds.
   4. Prevent erosion of the soil between completion of soil preparation and planting.

C. Concrete Mowbands and Wood Header Boards: Install in accordance with the Drawings and repeat specified initial preparations as necessary.

3.03 SOIL PREPARATION AND FINISH GRADES

A. Soil Preparation:
   1. Thoroughly roto-till the following additives into the top 6 inches of planting area soil at the following rates per 1,000 square feet:
      a. Soil Amendment: 6 Cubic Yards.
      b. Soil Conditioner: 200 Pounds.
      c. Pre-Plant Fertilizer: 35 Pounds.
      d. Soil Sulfur: 20 Pounds.
   1. The above additive recipe shall be used by Contractor for establishing the cost of soil additives in the Contract sum.
      a. A site specific fertility test shall be performed by the Contractor after rough grading and applicable topsoil placement or replacement operations are complete. Soil shall be sent to Gro-Power, or other testing agency approved by Owner's Representative, for tests.
      b. The results of the testing will be reviewed by the Owner Representative and direction for amendment additives ratio will be provided.
      c. The Contract sum will be modified, in accordance with the procedures for changes in the work included in the Contract, if there is a variance from the above specified additives or quantities.
   2. After additives are fully incorporated into the soil, the Contractor shall perform further testing to check conformance with the newly recommended materials and quantities. If deficiencies are found, the Contractor shall be solely responsible for the cost of adding deficient material as necessary and re-testing required to verify conformance.
   3. Contractor shall also schedule 7 working days after soil samples have been taken to allow for receipt and evaluation of soil tests at no cost or delay to the project.

B. Planting Area Finish Grades:
   1. After tilling in additives and re-compaction to 85 percent relative compaction, rake planting areas smooth and set finish grades as follows.
   2. After soil preparation, finish grades of planting areas shall be 1 inch below adjacent paving, headers, utility boxes, irrigation boxes, and other in-grade items. Finish grade slopes shall be consistent.
   3. Drainage structures, including catch basins, area drains, and concrete swales, shall be flush with finish grade to allow for proper drainage. Soil shall be sloped consistently from spot elevations provided to drain.
   4. In planting areas to receive mulch, depth of mulch shall taper within 3 feet of paving edge to a depth from 3 inches to 1 inch at edge of pavement.
   5. Irrigation head elevation relative to finish grade shall be installed as shown.
   6. After sand channel drainage system, finish grade shall be re-established.
   7. Infield fines and warning tracks shall be graded to be flush with depth of sod soil. If sod is at 3/4 inches, then that will be the difference of the sod subgrade to the infield fines finish grade prior to placement of the sod.

3.04 TREE, SHRUB AND GROUND COVER PLANTING

A. These areas shall receive specified topsoil and soil amendments prior to commencing with tree, shrub and ground cover planting.

B. Layout: Coordinate layout of plants with Owner's Representative for review and acceptance.

C. Plant Pit Excavation:
   1. Excavate pits to sizes indicated in Drawings.
   2. Thoroughly scarify all sides of plant pits to remove "auger slick" and encourage root penetration.

D. Set trees and shrubs in pit on tamped backfill base as per Details. Set plumb and face for best appearance. Thoroughly scarify all plant root balls to eliminate any circling roots and to encourage root growth. Set plant so root crown will level with or be slightly above surrounding grade after settlement.

E. Backfilling:
1. Backfill mix for 1 gallon size and larger shall consist of 100 percent native site soil with plant tabs added per manufacturer's recommendations.
2. Tamp backfill mix under and around root balls.
3. Flood plant pit when half backfilled; allow to drain.
4. Complete backfilling. Tamp as necessary, do not over compact.

F. Palm Pit Backfilling:
1. Fill the hole with washed plaster sand.
2. Water in as you fill hole with sand to wash the material around the exposed roots.
3. Avoiding leaving any air pockets or voids that will allow the roots to dry out.
4. The sand backfill should ensure good drainage plus provide rigidity so you may not have to brace the tree.

G. Watering:
1. Thoroughly water plants immediately after planting.
2. Construct water basins as specified in Drawings.

H. Finish Grade Restoration: Restore finish grades by hand raking. Dispose of excess subgrade soil.

3.05 TREE STAKING

A. Stake trees as shown in the Drawings.

B. Set stakes plumb, without damage to rootball and sufficiently deep to provide necessary support.

C. Tree ties shall be tied loosely enough to allow movement, yet taut enough to support tree.

3.06 HERBICIDE APPLICATION

A. Apply in accordance with manufacturers' recommendations.

B. Apply pre-emergent herbicide to soil prior to placement of bark mulch top-dress.

3.07 MULCH TOP DRESS

A. Apply 3 inches of specified bark mulch top dress to all non-turf and hydroseeded planting areas and other areas as may be specified in the Drawings.

B. Rake mulch top dress evenly to create a uniform surface and pull bark mulch top dress away from trunks or stalks of plants 1 to 2 inches.

C. Mulch shall not dictate finish grade in planting areas. Mulch is to be added to finish grade.

3.08 FIELD QUALITY CONTROL

A. The Owner's Representative will review and accept the following prior to the Contractor proceeding with subsequent work:
1. Preparation: At completion of finish grading and prior to planting, grading tolerances and soil preparation will be checked for conformance to Contract Documents.

2. Layout of plants, header board, and other major items shall be as directed and accepted by the Owner's Representative.
3. Pre-Maintenance Review: At completion of planting, work shall be reviewed for conformance with Contract Documents. Acceptance shall mark beginning of the specified maintenance period. If acceptance is not given, a punch-list of items requiring attention will be issued to the Contractor. One more review will be allowed after Contractor certifies in writing that the punch-list has been completed. Punch-list shall be completed to the satisfaction of the Owner's Representative prior to commencement of the Specified Maintenance Period.

B. Costs incurred from repeat reviews required due to Contractor not being prepared and other non-conformance with Contract Documents will be back charged to the Contractor.

END OF SECTION

SECTION 33 4000 – STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Storm drainage piping, fittings, and accessories.

1.02 RELATED DOCUMENTS

A. Unless otherwise specified, the work embraced herein shall conform to:

1. The Contract Documents (including but not limited to plans, project geotechnical reports, and project arborist reports).

2. The appropriate specifications of the Caltrans Standard Specifications insofar as the same may apply.

B. In the event of apparent conflicts between the Standard Specifications, the Standard Plans, the Standard Details, or the Contract Documents, those requirements, as determined by the Engineer, which gives the greatest protection to the owner or result in the best installation shall govern.

1.03 REFERENCE STANDARDS

A. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2005.

B. ASTM D 2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.

C. ASTM D 3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2004a.

D. ASTM A 48/A 48M - Standard Specification for Gray Iron Castings; 2003.

E. ASTM C 478 - Standard Specification for Precast Reinforced Concrete Manhole Sections; 2006a.

F. ASTM C 478M - Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric); 2006a.

G. ASTM C 923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals; 2002.

H. ASTM C 923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric); 2002.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories, and manholes.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Project Record Documents:

1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 - PRODUCTS

2.01 DRAINAGE STRUCTURES

A. Portland cement concrete for drainage structures shall contain at least six (6) sacks (564 pounds) of Type II Portland cement per cubic yard conforming to Section 90 of the Standard Specifications with combined aggregate grading of 1-1/2" inch maximum. Reinforcing steel shall conform to Section 52 of the Caltrans Standard Specifications.

B. Frames, grates, hoods, and other miscellaneous metal shall conform to first, the Standard Details and second, Section 75 of the Caltrans Standard Specifications, insofar as they are applicable.

2.02 PRE-CAST CONCRETE MANHOLE SECTIONS

A. Pre-cast reinforced concrete manhole sections shall conform to the requirements of ASTM C478, except that manhole steps and ladders shall not be provided unless specifically required in the Contract Documents.

2.03 SEWER PIPE MATERIALS

A. Plastic Pipe: ASTM D 2729, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 6 inches, bell and spigot style gasket (not solvent) sealed joint end.

B. Small diameter inlet and outlet drain piping shall be gasketed watertight pipe.

PART 3 - IMPLEMENTATION

3.01 DRAINAGE STRUCTURE

A. Concrete drainage structures may be pre-cast, from a supplier in the regular business of pre-cast concrete structures.

B. Concrete drainage structures may be cast in place unless otherwise indicated in the Contract Documents. Forms shall be inspected and approved by the Engineer prior to placement of concrete. Expansion and contraction joints shall be placed as required by the Contract Documents and as directed by the Engineer. Drainage structures shall be poured monolithically unless otherwise indicated. Not more than thirty (30) minutes shall elapse between successive pours for an individual structure. All concrete shall be used while fresh and before it has taken an initial set. Re-tempering any partially hardened concrete with additional water or by vibrating shall not be permitted. Concrete additives require the written approval of the Engineer. The contractor shall submit a concrete mix design for review and approval to the Engineer a minimum of one (1) week in advance of making any pours. A smooth trowel finish shall be applied to all exposed portions of the structure. The floor of the structure shall have slope from inlet to outlet and shall be free of "birdbaths" over .04 feet in depth.

C. Excavation and backfill shall conform to Section 19 of the Caltrans Standard Specifications, unless otherwise indicated, and to the Contract Documents. The Contractor

is to coordinate with the Campus who will install "No Dumping Flows to Bay" plaques near newly constructed catch basins.

3.02 MANHOLE

A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C 478 (ASTM C 478M), with resilient connectors complying with ASTM C 923 (ASTM C 923M).

B. Set cover frames and covers level without tipping, to correct elevations.

3.03 TRENCHING - SEE SECTION 31 2313, ARTICLE 3.06 D. UTILITIES

A. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.

C. Plastic Pipe: Also comply with ASTM D 2321.

D. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

E. Connect to manholes.

F. Install continuous trace wire 6 inches above top of pipe; coordinate with Section 31 2210.

3.05 CATCH BASINS AND CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.

3.06 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 4000.

B. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest at no cost to Sonoma State University.

C. Infiltration Test: Test in accordance with industry standard for "Water Tight" storm drain pipe.

3.07 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SOLANO COMMUNITY COLLEGE DISTRICT

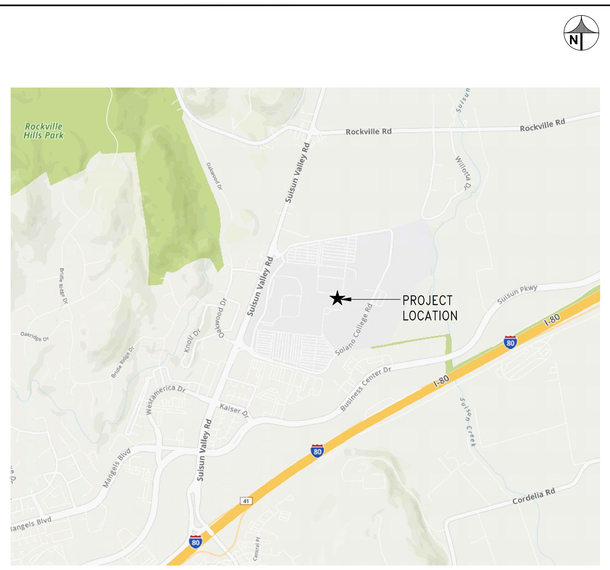
SOLANO COMMUNITY COLLEGE

4000 SUISUN VALLEY RD
FAIRFIELD, CA 94534

SUBSTATION #3 & #4 REPLACEMENT

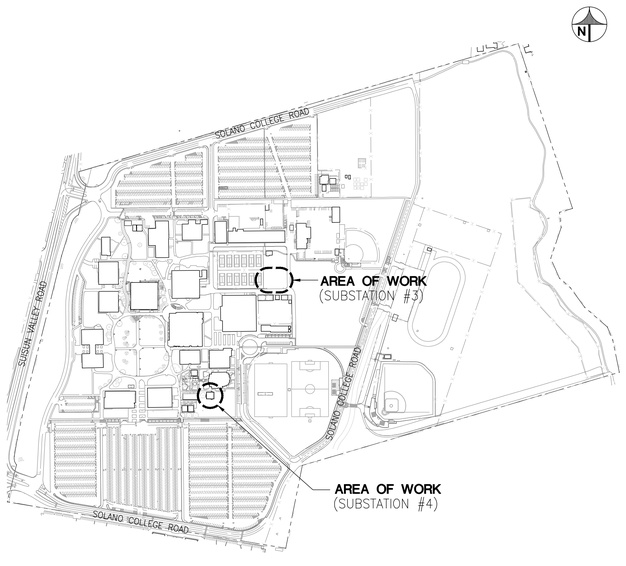
VICINITY MAP

SCALE: N.T.S.



SITE PLAN

SCALE: N.T.S.



APPLICABLE CODES

UNLESS OTHERWISE INDICATED OR SPECIFIED, PERFORM THE WORK IN CONFORMANCE WITH THE LATEST EDITIONS OF ALL APPLICABLE REGULATORY REQUIREMENTS, INCLUDING, BUT NOT LIMITED TO, THE FOLLOWING:

1. CALIFORNIA BUILDING STANDARDS ADMINISTRATIVE CODE (PART 1, TITLE 24): 2019
2. CALIFORNIA BUILDING CODE (PART 2, TITLE 24): 2018 IBC WITH 2019 CA AMENDMENTS
3. CALIFORNIA ELECTRICAL CODE (PART 3, TITLE 24): 2017 NEC WITH 2019 CA AMENDMENTS
4. CALIFORNIA MECHANICAL CODE (PART 4, TITLE 24): 2018 UMC WITH 2019 CA AMENDMENTS
5. CALIFORNIA PLUMBING CODE (PART 5, TITLE 24) 2018 UPC WITH 2019 CA AMENDMENTS
6. CALIFORNIA ENERGY CODE (PART 6, TITLE 24): 2019
7. CALIFORNIA HISTORICAL BUILDING CODE, (PART 8, TITLE 24): 2019
8. CALIFORNIA FIRE CODE (PART 9, TITLE 24): 2018 IFC WITH 2019 CA AMENDMENTS
9. CALIFORNIA EXISTING BUILDING CODE (PART 10, TITLE 24): 2019 (2018 INTERNATIONAL EXISTING BUILDING CODE WITH 2019 CA AMENDMENTS)
10. CALIFORNIA GREEN BUILDING STANDARDS CODE OR CAL GREEN (PART 11, TITLE 24): 2019
11. CALIFORNIA REFERENCED STANDARDS CODE (PART 12, TITLE 24): 2019
12. PUBLIC SAFETY (CCR TITLE 19), STATE FIRE MARSHAL: CURRENT REVISION
13. NFPA 72, NATIONAL FIRE ALARM CODE, 2016 EDITION

DESIGN BUILD REQUIREMENTS

1. IN ADDITION TO SPECIFIED DESIGN BUILD PROJECT REQUIREMENTS, CONTRACTOR SHALL BE REQUIRED TO PROVIDE ENGINEERING, STRUCTURAL AND ARCHITECTURAL DESIGN DRAWINGS, SHOP DRAWINGS, CONSTRUCTION DRAWINGS, DETAIL DRAWINGS, CALCULATIONS, AND PRODUCT SUBMITTALS TO COLLEGE FOR REVIEW AND APPROVAL. ALL DOCUMENTS SUBMITTED FOR APPROVAL MUST BE PREPARED BY QUALIFIED PROFESSIONALS IN ACCORDANCE WITH CALIFORNIA STATE LAW. NO ITEMS SHALL BE INSTALLED WITHOUT WRITTEN COLLEGE APPROVAL. EACH DRAWING SHALL BE SIGNED, SEALED AND DATED BY CALIFORNIA LICENSED PROFESSIONAL(S) RESPONSIBLE FOR DESIGN. ALL SUCH PROFESSIONAL SERVICES SHALL MEET OR EXCEED PROFESSIONAL STANDARD AND QUALITY WHICH PREVAIL AMONG LICENSED PROFESSIONALS OF SIMILAR KNOWLEDGE AND SKILL ENGAGED IN RELATED WORK THROUGHOUT CALIFORNIA UNDER SAME OR SIMILAR CIRCUMSTANCES.

2. CONTRACTOR SHALL BE REQUIRED TO DESIGN AND BUILD THIS PROJECT. THESE CONTRACT DOCUMENTS ARE INTENDED TO SET FORTH MAJOR ELEMENTS/REQUIREMENTS OF DESIGN/BUILD PROGRAM CRITERIA. REQUIREMENTS DESCRIBED WITHIN THESE CONTRACT DOCUMENTS SHALL BE INCORPORATED INTO DESIGN. HOWEVER, NOT ALL DESIGN ELEMENTS, ISSUES, OR SPECIFIC DETAILS HAVE BEEN INCLUDED. DESIGN ELEMENTS, ISSUES, OR SPECIFIC DETAILS THAT ARE NOT SPECIFICALLY NOTED, BUT THAT ARE DEEMED NECESSARY BY COLLEGE FOR SUCCESSFUL COMPLETION OF THIS PROJECT SHALL BE DESIGN/BUILD RESPONSIBILITY OF CONTRACTOR. CONTRACTOR SHALL BE RESPONSIBLE TO INCLUDE AND VALIDATE ALL SUCH ELEMENTS WITH COLLEGE. ELECTRONIC CAD FILES FOR DRAWINGS AND SPECIFICATIONS ARE AVAILABLE UPON REQUEST FROM COLLEGE.

3. CONTRACTOR'S PROPOSED DESIGN IS REQUIRED TO MEET ALL REQUIREMENTS OF COLLEGE AND BE APPROVED BY COLLEGE. COMPLETION OF DESIGN IS RESPONSIBILITY OF CONTRACTOR AND SHALL INCLUDE ALL WORK NECESSARY TO PRODUCE FULLY-FUNCTIONAL, CODE COMPLIANT SITE AND STRUCTURE, TO SATISFACTION OF COLLEGE. FULL DESIGN RESPONSIBILITY SHALL ALSO INCLUDE, BUT NOT LIMITED TO, CONDUCTING DESIGN INQUIRIES, GATHERING PROGRAMMING DESIGN DATA, SITE VERIFICATION OF FIELD CONDITIONS, DESIGN FEASIBILITY, DESIGN ALTERNATIVES, AND PRODUCTION OF FINAL CONSTRUCTION DOCUMENTS. CONTRACTOR SHALL COMPLY WITH ALL COLLEGE REQUIREMENTS EITHER AS RESULT OF COMMENTS MADE DURING REVIEW/APPROVAL PROCESS OR DURING FINAL INSPECTION OF PROJECT.

4. THESE CONTRACT DOCUMENTS ARE INTENDED ONLY TO GENERALLY DESCRIBE MINIMUM WORK, LEVEL OF QUALITY EXPECTED, AND TYPES OF EQUIPMENT TO BE UTILIZED. ACCOMPANYING REFERENCE DRAWINGS ARE INCLUDED FOR CONTRACTOR'S USE TO AID IN PRODUCING BID PROPOSAL AS WELL AS COMPLETE DESIGN/BUILD ENGINEERING DOCUMENTS AS REQUIRED. REFERENCE DRAWING PACKAGE GENERALLY SHOWS WORK TO BE CONSTRUCTED. ACCURACY OF DRAWINGS OR THEIR CONTENTS IS NOT GUARANTEED TO REFLECT ACTUAL SITE/INSTALLATION CONDITIONS AND IS SUBJECT TO CONTRACTOR FIELD VERIFICATION.

5. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL FIELD WORK, FIELD SURVEYS, AND SITE VISITS TO DOCUMENT, CONFIRM, AND VERIFY EXISTING CONDITIONS, AND MAKE REVISIONS/MODIFICATIONS TO ACCURATELY REFLECT ACTUAL SITE CONDITIONS, AND OBTAIN ALL NECESSARY DESIGN INFORMATION REQUIRED FOR SUCCESSFUL PROJECT COMPLETION. SUCH MODIFICATIONS SHALL INCLUDE, BUT ARE NOT LIMITED TO, DRAWING SCALE, DIMENSIONS, UTILITY BOXES, SURFACE CONDITIONS, AND OTHER PERTINENT DESIGN RELATIONSHIPS. CONTRACTOR SHALL NOT PROCEED WITH ANY CONSTRUCTION UNTIL COLLEGE APPROVES FINAL DESIGN DOCUMENTS IN WRITING.

6. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING AND OBTAINING ALL FINALIZED DESIGN CRITERIA FROM COLLEGE PRIOR TO OR PROGRESSIVELY DURING DESIGN ENGINEERING PROCESS. FINAL DESIGN SHALL MEET ALL COLLEGE CRITERIA FOR SPECIFIC PRODUCTS/EQUIPMENT, INSTALLATION METHODS, DESIGN LAYOUTS, CONSTRUCTION IMPLEMENTATION, WORKMANSHIP, BUDGET, CODE COMPLIANCE, DOCUMENTATION, OPERATION, AND MAINTENANCE.

7. ALL ELECTRICAL EQUIPMENT AND MATERIALS SHALL BE NEW, UL LISTED AND APPROVED FOR APPLICATION INTENDED.

8. CONTRACTOR SHALL BE FULLY RESPONSIBLE AND LIABLE FOR ADEQUACY OF SYSTEMS/EQUIPMENT DESIGN AND INSTALLATION REQUIRED BY THIS PROJECT. CONTRACTOR SHALL INDEMNIFY, DEFEND AND HOLD COLLEGE HARMLESS FROM ANY CLAIM, DAMAGES, LOSS OR EXPENSE ARISING OUT OF OR RESULTING FROM CONTRACTOR'S DESIGN WORK PRODUCT OR CONTRACTOR'S FAILURE TO DESIGN SYSTEM IN ACCORDANCE WITH THIS ATTACHMENT AND THESE CONTRACT DOCUMENTS.

9. CONTRACTOR REPRESENTS AND WARRANTS THAT ALL DRAWINGS, SPECIFICATIONS, AND OTHER DESIGN WORK PRODUCTS ARE PROPERTY OF COLLEGE WITHOUT RESTRICTIONS OR LIMITATION UPON USE.

DRAWING INDEX

SCOPE OF WORK

1. REMOVE EXISTING SUBSTATION #3.
2. DESIGN, PROVIDE, AND INSTALL NEW SUBSTATION #3 (SUBSTATIONS #3.1 & #3.2).
3. REMOVE EXISTING SUBSTATION #4.
4. DESIGN, PROVIDE, AND INSTALL NEW SUBSTATION #4.
5. REMOVE EXISTING LV SWITCHBOARDS AND FEEDERS WHERE IDENTIFIED.
6. DESIGN, PROVIDE, AND INSTALL LV SWITCHBOARDS AND FEEDERS WHERE IDENTIFIED.
7. DESIGN, PROVIDE, AND INSTALL NEW UNDERGROUND ELECTRICAL VAULTS AND PULL BOXES WHERE IDENTIFIED.
8. DESIGN, PROVIDE, AND INSTALL NEW MV DISCONNECT SWITCH WHERE IDENTIFIED.

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REGISTERED PROFESSIONAL ENGINEER
HSIEN T. KING
No. E20639
ELECTRICAL
STATE OF CALIFORNIA

SOLANO COMMUNITY COLLEGE DISTRICT

SOLANO COMMUNITY COLLEGE

4000 SUISUN VALLEY RD
FAIRFIELD, CA 94534

SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

ISSUE MARK	DATE	DESCRIPTION
	06/28/22	PROGRESS SET #1
	07/28/22	DESIGN-BUILD DRAWING SET

SOBE PROJECT NO:	2200690
DATE:	07/28/22
DRAWN BY:	
CHECKED BY:	MM
APPROVED BY:	HK

SHEET TITLE

COVER SHEET

SCALE: AS NOTED
THIS DRAWING IS 30" X 42" AT FULL SIZE

E-0.0

SHEET OF XX

DEMOLITION NOTES

1. REMOVE EXISTING EQUIPMENT IN CONFLICT WITH NEW CONDITIONS. REMOVE ALL WIRE NOT IN SERVICE AND FROM ABANDONED RACEWAYS. PROTECT EXISTING CIRCUITING PASSING THROUGH DEMOLITION AREAS. EXTEND AND/OR RELOCATE AS NECESSARY.
2. ALL ABANDONED EQUIPMENT INCLUDING LIGHT, RECEPTACLES, DATA, FIRE ALARM, ETC., SHALL BE COVERED WITH BLANK METAL PLATES AND PAINTED TO MATCH THE ADJACENT FINISH OF SURROUNDING WALLS OR CEILING TO THE SATISFACTION OF THE ARCHITECT/OWNER.
3. ELECTRICAL CONTRACTOR IS RESPONSIBLE TO DISCONNECT AND REMOVE ALL EXISTING ELECTRICAL EQUIPMENT AFFECTED BY THE PROJECT. THIS INCLUDES REROUTING OR THE EXTENSION OF EXISTING CONDUIT AND FEEDER WHERE NECESSARY TO MAINTAIN OPERATIONAL OF ANY EXISTING EQUIPMENT.
4. CIRCUIT NUMBERS AND CONDUIT HOMERUNS SHOWN ON THESE DRAWINGS WERE TAKEN FROM EXISTING RECORD DRAWINGS. ELECTRICAL CONTRACTOR IS RESPONSIBLE TO VERIFY EXISTING CIRCUITING AND CONDUIT HOMERUNS. ADJUST CIRCUIT NUMBERS ACCORDING TO THE ACTUAL CONDITIONS.
5. WHERE EXISTING CONDUIT IS TO BE ABANDONED OR DEMOLISHED, THE CONDUIT SHALL BE REMOVED IF IT IS EXPOSED, IN A CRAWL SPACE OR IN AN ACCESSIBLE CEILING. ABANDONED OR DEMOLISHED CONDUIT FEEDS UP THROUGH THE FLOOR SHALL BE CUT OFF AND PLUGGED FLUSH WITH THE FLOOR.
6. ALL ELECTRICAL EQUIPMENT INCLUDING LIGHT, RECEPTACLE, DATA, FIRE ALARM, ETC., THAT ARE TO BE REMOVED, SHALL BE REMOVED COMPLETELY, INCLUDING CONDUIT AND WIRING BACK TO THE LAST DEVICE REMAINING IN SERVICE, OR SOURCE.
7. EXISTING CIRCUITS WHICH ARE REMOVED AND NOT REUSED SHALL BE IDENTIFIED ON THE PANEL SCHEDULE AS "SPARE".
8. ELECTRICAL CONTRACTOR SHALL COORDINATE WITH THE OWNER PRIOR TO REMOVAL OF EXISTING ELECTRICAL EQUIPMENT AND TURN OVER REMOVED EQUIPMENT THAT THE OWNER REQUESTS IN AN "AS–FOUND" CONDITION.
9. ALL DEMOLITION WORK SHOWN, IF ANY, WAS PREPARED FOR THE CONVENIENCE OF THE CONTRACTOR. NO REPRESENTATION HAS BEEN MADE THAT ALL ITEMS THAT MAY REQUIRE DEMOLITION HAVE BEEN SHOWN. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO CAREFULLY EXAMINE THE SITE AND THE CONTRACT DOCUMENTS AND TO PERFORM ALL DEMOLITION AND RECONSTRUCTION WHICH MAY BE REQUIRED FOR THE PROPER EXECUTION AND COMPLETION OF THE WORK.
10. WHEN CALLED FOR, OR SCOPE OF WORK REQUIRES ELECTRICAL EQUIPMENT TO BE REMOVED, ALL CONDUIT, WIRE, BOXES, HANGERS, ETC. SHALL BE REMOVED COMPLETELY. ALL OPENINGS SHALL BE PATCHED, SEALED AND PAINTED TO MATCH THE ADJACENT FINISH.

LOAD CALCULATIONS

ELECTRICAL LOAD CALCULATIONS - NEW SUBSTATION #3

	HP/UNIT	KVA/UNIT	QTY	SUB #3 SUB-TOTAL LOAD (KVA)	SUB #3.1 SUB-TOTAL LOAD (KVA)	SUB #3.2 SUB-TOTAL LOAD (KVA)
LIGHTING (CP):						
3,830 SF @ 2VA/SF		8				
LTG LOAD @ 125%		10	1	10	10	0
GENERAL RECEPTACLES (CP):						
3,830 SF @ 1VA/SF		4				
1ST 10KVA @ 100%		4	1	4	4	0
MECHANICAL EQUIPMENT (CP):						
<E> CH-1:						
- 370HP - 475A MCA	370	397	1	397	397	0
- 477A FLC @ 480V - NEC TABLE						
<E> CH-2:						
- 370HP - 475A MCA	370	397	1	397	0	397
- 477A FLC @ 480V - NEC TABLE						
<E> CH-3:						
- 236HP - 349A MCA	236	237	1	237	0	237
- 285A FLC @ 480V - NEC TABLE						
<E> CHWP-1 (100HP) - FED BY <E> MCC 'CP'	100	103	1	103	0	103
<E> CHWP-2 (100HP) - FED BY <E> MCC 'CP'	100	103	1	103	0	103
<E> CHWP-3 (50HP) - FED BY <E> MCC 'CP'	50	54	1	54	0	54
<E> GAS BOILER-1 (2HP) - TO BE REPLACED BY <F> EB'S	2	3	0	0	0	0
<E> GAS BOILER-2 (2HP) - TO BE REPLACED BY <F> EB'S	2	3	0	0	0	0
<E> GAS BOILER-3 (2HP) - TO BE REPLACED BY <F> EB'S	2	3	0	0	0	0
<N> ELECTRIC BOILER-1		840	1	840	840	0
<N> ELECTRIC BOILER-2		840	1	840	0	840
<N> ELECTRIC BOILER-3		840	1	840	840	0
<F> ELECTRIC BOILER-4		800	1	800	0	800
<F> ELECTRIC BOILER-5		800	1	800	800	0
<F> ELECTRIC BOILER-6		800	1	800	0	800
<E> HHWP-1 (60HP) - FED BY <E> MCC 'CP'	60	64	1	64	0	64
<E> HHWP-2 (60HP) - FED BY <E> MCC 'CP'	60	64	1	64	0	64
<E> HHWP-3 (60HP) - FED BY <E> MCC 'CP'	60	64	1	64	0	64
<E> CT-1 (50HP FAN) - FED BY <E> MCC 'CT'	50	54	1	54	54	0
<E> CT-2 (50HP FAN) - FED BY <E> MCC 'CT'	50	54	1	54	54	0
<E> CS-1 (15HP PUMP) - FED BY <E> MCC 'CT'	15	17	1	17	17	0
<E> CWP-1 (60HP) - FED BY <E> MCC 'CT'	60	64	1	64	64	0
<E> CWP-2 (60HP) - FED BY <E> MCC 'CT'	60	64	1	64	64	0
<E> CWP-3 (30HP) - FED BY <E> MCC 'CT'	30	33	1	33	33	0
<E> EF-1 (3/4HP) - FED BY <E> MCC 'CP'	0.75	1	1	1	0	1
<-> EF-2 (3HP) - FED BY <E> MCC 'CP'	3	4	1	4	0	4
NON-COINCIDENT LOADS:						
N/A.						
OTHER LOADS:						
<E> BUILDING 1700A (600A MCB - 480V @ 60%)		299	1	299	299	0
<E> TENNIS COURT (100A MCB - 480V @ 60%)		50	1	50	0	50
<E> POOL EQ (200A MCB - 480V @ 60%)		100	1	100	0	100
<E> SID (2x30HP - 480V)	30	33	2	67	67	0
<E> CHWP-1700A (10HP - 480V) - FED BY <E> MCC 'CP'	10	12	1	12	0	12
LARGEST MOTOR @ 25%:						
<E> 370HP @ 25%		99	1	99	99	99

	SUB #3 (SUB'S 3.1 & 3.2)	SUB #3.1	SUB #3.2
TOTAL DEMAND LOAD (KVA) =	7,334	3,642	3,791
DEMAND LOAD AMPS @ 12.47KV - 3PH =	340	169	176
DEMAND LOAD AMPS @ 480V - 3PH =	8,821	4,380	4,560
SYSTEM CAPACITY (A) @ 480V - 3PH =	10,000	5,000	5,000
REMAINING CAPACITY (A) @ 480V - 3PH =	1179 (12%)	620 (12%)	440 (9%)
TOTAL TRANSFORMER SIZE (KVA) =	7,500 + 25% (9,375)	3,750 + 25% (4,687.5)	3,750 + 25% (4,687.5)

GENERAL NOTES

1. CONTRACTOR IS RESPONSIBLE TO OBTAIN A COMPLETE SET OF CONTRACT DOCUMENTS, ADDENDA, DRAWINGS, AND SPECIFICATIONS. PRIOR TO SUBMITTING PROPOSAL, CONTRACTOR SHALL EXAMINE ARCHITECTURAL, STRUCTURAL AND MECHANICAL CONSTRUCTION DRAWINGS AND SPECIFICATIONS AND SHALL HAVE VISITED THE CONSTRUCTION SITE. HE/SHE SHALL BE FAMILIAR WITH THE EXISTING CONDITIONS UNDER WHICH HE/SHE WILL HAVE TO OPERATE AND WHICH WILL IN ANY WAY AFFECT THE WORK UNDER THIS CONTRACT. NO SUBSEQUENT ALLOWANCE WILL BE MADE IN THIS CONNECTION IN BEHALF OF THE CONTRACTOR FOR ANY ERROR OR NEGLIGENCE ON HIS/HER PART. DETERMINE THE SEQUENCE OF CONSTRUCTION THROUGHOUT THE PROJECT, INCLUDING TEMPORARY FACILITIES AND CONNECTIONS REQUIRED FOR THE DURATION OF THE PROJECT.
2. ALL TEMPORARY CONNECTIONS SHALL BE CONSIDERED PART OF THIS CONTRACT AND NO EXTRA CHARGES WILL BE ALLOWED. THIS SHALL INCLUDE MINOR ITEMS OF MATERIAL OR EQUIPMENT NECESSARY TO MEET THE REQUIREMENTS AND INTENT OF THE PROJECT.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SAFETY OF PERSONS AND PROPERTY AND SHALL PROVIDE INSURANCE COVERAGE AS NECESSARY FOR LIABILITY, PERSONAL, AND PROPERTY DAMAGE, TO FULLY PROTECT THE OWNER, ARCHITECT, AND ENGINEER FROM ANY AND ALL CLAIMS RESULTING FROM THIS WORK.
4. THE CONTRACTOR SHALL PROVIDE TO THE ARCHITECT A CONSTRUCTION SCHEDULE OF ALL ELECTRICAL WORK. THE CONSTRUCTION SCHEDULE SHALL IDENTIFY ALL SIGNIFICANT MILESTONES WITH COMPLETION DATES.
5. THE CONTRACTOR SHALL MAINTAIN RECORD DRAWINGS AT THE PROJECT SITE INDICATING ALL MODIFICATIONS TO ELECTRICAL SYSTEMS. THE CONTRACTOR SHALL, AT THE CONCLUSION OF THE PROJECT, PROVIDE A SET OF REPRODUCIBLE (AUTOCAD), ACCURATE AND NEAT "AS–BUILT" DRAWINGS ACCEPTABLE TO THE ARCHITECT.
6. THESE DRAWINGS DO NOT REPRESENT THE EXACT LOCATIONS, SIZES OR EXTENT OF UTILITIES ON SITE. CONTRACTOR SHALL TAKE STANDARD PRECAUTIONS FOR WORK IN EXISTING FACILITIES.
7. EXISTING ELECTRICAL WIRING WHICH WILL NOT BE MADE OBSOLETE AND WHICH WILL BE DISTURBED DUE TO CONSTRUCTION CHANGES REQUIRED BY THIS CONTRACT SHALL BE RESTORED TO OPERATING CONDITION, AS REQUIRED AND/OR DIRECTED. WHERE REQUIRED, SHOWN AND/OR DIRECTED, OUTLETS AND CONDUIT RUNS SHALL BE RELOCATED. IN SOME CASES IT MAY BE NECESSARY TO EXTEND CONDUITS AND PULL IN NEW WIRING OR INSTALL JUNCTION BOXES AND SPLICE IN NEW WIRING OR REPLACE OLD WIRING WITH NEW.
8. CERTAIN REMODELING OF ELECTRICAL FACILITIES WILL BE REQUIRED IN THE EXISTING BUILDING. EXISTING CONDUIT RUNS ARE GENERALLY NOT SHOWN, ALTHOUGH A FULL ATTEMPT HAS BEEN MADE TO SHOW SOME EXISTING CONDITIONS, OF WHICH INFORMATION HAS BEEN TAKEN FROM EXISTING RECORD DRAWINGS AND/OR LIMITED FIELD INVESTIGATIONS. THE DRAWINGS SHOWING LOCATION OF EXISTING EQUIPMENT, OUTLETS, FIXTURES, ETC., ARE APPROXIMATE ONLY (CONTRACTOR TO FIELD VERIFY).
9. ALL ELECTRICAL MATERIALS AND EQUIPMENT SHALL BE NEW AND SHALL BE LISTED AND LABELED BY A NATIONALLY RECOGNIZED TESTING LABORATORY AND SHALL BE INSTALLED AS PER LISTING OR LABELING (IE. MAXIMUM FUSE SIZE MEANS FUSE PROTECTION IS REQUIRED).
10. ALL ELECTRICAL EQUIPMENT AND INSTALLATION SHALL COMPLY WITH THE FOLLOWING REQUIREMENTS:
    a. AMERICAN STANDARD ASSOCIATION (ASA)
    b. AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)
    c. AMERICAN SOCIETY OF TESTING MATERIALS (ASTM)
    d. CALIFORNIA CODE OF REGULATIONS TITLE 24 (CCR)
    e. INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)
    f. INSULATED POWER CABLE ENGINEERS ASSOCIATIONS (IPCEA)
    g. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATIONS (NEMA)
    h. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
    i. ALL LOCAL CODE HAVING JURISDICTION
11. CONTRACTOR SHALL SECURE AND PAY FOR ALL PERMITS, FEES, INSPECTIONS AND INCIDENTAL COSTS NECESSARY FOR EXECUTION AND COMPLETION OF ELECTRICAL WORK, INCLUDING ALL CHARGES BY STATE, COUNTY AND LOCAL GOVERNMENTAL AGENCIES. CONTRACTOR SHALL BE RESPONSIBLE FOR THE ELECTRICAL UTILITY SYSTEM SHUT–DOWNS AND START–UP. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION REQUIRED WITH OTHER AGENCIES AND UTILITY COMPANIES.
12. CONTRACTOR IS RESPONSIBLE FOR COORDINATING ALL CROSSINGS ON NEW UTILITIES WITH THAT OF EXISTING ON SITE AND IN ADJACENT PROPERTIES. NOTIFY THE ENGINEER IMMEDIATELY OF ANY DEVIATIONS OR DISCREPANCIES FROM THIS PLAN.
13. CONTRACTOR SHALL COORDINATE HIS/HER WORK WITH OTHER TRADE ON SITE. ANY COST TO PERFORM WORK TO ACCOMPLISH SAID COORDINATION WHICH DIFFERS FROM THE WORK AS SHOWN ON THE DRAWINGS SHALL BE INCURRED BY THE CONTRACTOR. ANY DISCREPANCIES, AMBIGUITIES OR CONFLICTS SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT DURING BID TIME FOR CLARIFICATIONS. ANY SUCH CONFLICTS NOT CLARIFIED PRIOR TO BID SHALL BE SUBJECT TO THE INTERPRETATION OF THE ARCHITECT/ENGINEER AT NO ADDITIONAL COST TO THE OWNER.
14. COORDINATE WITH OTHER TRADES AS TO THE EXACT LOCATION OF THEIR RESPECTIVE EQUIPMENT. PROVIDE POWER AND CONNECTION TO MOTORS AND EQUIPMENT REQUIRING ELECTRICAL CONNECTIONS AS INDICATED ON ELECTRICAL DRAWINGS AND DRAWINGS OF OTHER TRADES. CONTRACTOR SHALL REVIEW DRAWINGS OF OTHER TRADES FOR CONTROL DIAGRAMS, SIZE AND LOCATION OF EQUIPMENT. DISCONNECT SWITCHES, STARTERS, AND CONDUITS FOR CONTROL WIRING FOR MECHANICAL AND PLUMBING EQUIPMENT SHALL BE PROVIDED BY ELECTRICAL CONTRACTOR. CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING MANUFACTURER'S SHOP DRAWINGS PRIOR TO ROUGHING IN ALL CONDUITS TO THIS EQUIPMENT.
15. BEFORE ROUGH–IN, VERIFY ALL MOUNTING HEIGHTS AND EXACT LOCATIONS FOR ALL EQUIPMENT, ELECTRICAL CONNECTIONS, STUB–UPS, RECEPTACLES, OUTLETS, CONDUIT RUNS, ETC. WITH ARCHITECT AND OWNER. PLACE DEVICES LOCATED ABOVE COUNTERS, SHELVING, ETC. AND IN BATHROOMS SO AS NOT TO CONFLICT WITH EDGES OF WAINSCOTING, COUNTER SPLASH, SHELVING, ETC. ARCHITECTURAL DRAWINGS SHALL GOVERN. REFER TO ARCHITECTURAL ELEVATIONS FOR EXACT LOCATIONS OF ELECTRICAL DEVICES
16. MOUNTING HEIGHTS OF ALL CONTROL DEVICES TO BE USED BY OCCUPANT OF THE ROOM OR AREA SHALL BE MOUNTED AT THE FOLLOWING HEIGHTS:
    RECEPTACLES OUTLETS : +18" (TO BOTTOM OF OUTLETS)
    TELEPHONE/TV/DATA OUTLETS : +18" (TO BOTTOM OF OUTLETS)
    LIGHT SWITCHES : +44" (TO HIGHEST OPERABLE PART)
    OUTLETS ABOVE COUNTER : +44" (TO HIGHEST OPERABLE PART)
    MOUNTING HEIGHTS OF ALL DEVICES AND EQUIPMENT ARE FROM FINISHED FLOOR TO LOCATION OF DEVICE AS NOTED. EQUIPMENT INSTALLED IN LOCATIONS NOT APPROVED BY THE ARCHITECT SHALL BE RELOCATED AS DIRECTED BY THE ARCHITECT AT NO ADDITIONAL COST TO THE OWNER.
17. COORDINATE ALL OUTLET BOX INSTALLATION WITH ARCHITECTURAL WALL FINISH SCHEDULES. SPACE BETWEEN FACEPLATE AND DEVICE BOX SHALL NOT EXCEED 1/8".
18. FOR RENOVATION WORK, THE CONTRACTOR SHALL CONCEAL ALL WORK WHERE POSSIBLE. ALL EXPOSED RACEWAY AND BOXES IN OCCUPIED AREAS OR ON EXTERIOR WALLS SHALL BE PAINTED TO MATCH ADJACENT FINISHES.
19. THE CONTRACTOR SHALL BE HELD FULLY RESPONSIBLE FOR THE PROPER RESTORATION OF ALL EXISTING SURFACES REQUIRING PATCHING, PLASTERING, PAINTING AND/OR OTHER REPAIR DUE TO THE INSTALLATION OF ELECTRICAL WORK UNDER THE TERMS OF THIS SPECIFICATION. CLOSE ALL OPENINGS, REPAIR ALL SURFACES, ETC., AS REQUIRED.
20. SEAL ALL CONDUIT PENETRATIONS THROUGH FIRE RATED WALLS AND CEILINGS. FURNISH AND INSTALL FIRE RATED BACKBOXES AS REQUIRED, MAINTAINING FIRE RATING OF CEILING OR WALLS WHERE RECESSED ELECTRIC EQUIPMENT SUCH AS LIGHT FIXTURES, SWITCHES, RECEPTACLES, PANEL, ETC. ARE INSTALLED IN RATED WALL OR CEILINGS. PENETRATIONS OF FIRE RATED WALLS, CEILINGS, OR FLOORS SHALL COMPLY WITH CBC CHAPTER 7 (714) REQUIREMENTS. CONDUIT PENETRATIONS THAT ARE NOT STUBBED–OUT INSIDE THE WALL SHALL MEET F AND T RATING. ALL FIRE PROOFING METHODS SHALL BE UL APPROVED.
21. ALL EXTERIOR EQUIPMENT SHALL BE NEMA 3R RATED. ALL WALL PENETRATIONS TO EXTERIOR WALLS SHALL BE SEALED WATER TIGHT.
22. PULLING TAPES: ALL RACEWAY WITHOUT CABLE OR WIRE SHALL BE INSTALLED WITH A MINIMUM 1100 LBS. STRENGTH TEST POLYESTER PULLING TAPE. PULLING TAPES SHALL BE DETECTABLE MULE–TAPE WITH SEQUENTIAL FOOTAGE MARKING.
23. RUN NO MORE THAN 3 CURRENT CARRYING CONDUCTORS IN ANY WIREWAY UNLESS DE–RATING IS APPROVED BY ENGINEER OR SHOWN ON DRAWINGS.
24. ALL BRANCH CIRCUIT CONDUCTORS SHALL BE COPPER, #10 AWG MINIMUM, RATED FOR 600V, THHN/THWN, 75 DEGREE CELSIUS. ALL CONDUCTORS SHALL BE STRANDED, SOFT DRAWN ANNEALED COPPER WIRE 98% CONDUCTIVITY, BEARING THE UL LABEL. SYSTEM VOLTAGE SHALL BE IDENTIFIED AS TO VOLTAGE AND PHASE CONNECTIONS BY MEANS OF COLOR IMPREGNATED INSULATION OR APPROVED COLORED MARKING TAPE.
25. WHERE MULTI–HOMERUNS ARE INDICATED ON DRAWINGS INDICATING THE SAME CIRCUIT NUMBER, PROVIDE A JUNCTION BOX ABOVE THE ACCESSIBLE CEILING AND ROUTE ONE SET OF WIRES TO THE CIRCUIT BREAKER.
26. REFER TO THE SINGLE LINE DIAGRAM FOR THE CONDUIT AND CONDUCTOR SIZES HOMERUN TO ELECTRICAL PANELS. CONDUIT RUNS MAY NOT BE SHOWN ON DRAWINGS, BUT ARE PART OF THIS CONTRACT.
27. ALL CONDUIT RUNS INCLUDING STRAIGHT FEEDER AND BRANCH CIRCUIT SHALL BE PROVIDED WITH SUFFICIENT PULL BOXES OR JUNCTION BOXES TO LIMIT THE MAXIMUM LENGTH OF ANY SINGLE CABLE PULL TO 100 FEET. PULL BOXES SHALL BE SIZED PER CODE OR AS INDICATED ON DRAWINGS. LOCATIONS SHALL BE DETERMINED IN THE FIELD OR AS INDICATED ON THE DRAWINGS.
28. FINAL CONNECTIONS TO ALL EQUIPMENT SHALL BE PER MANUFACTURER'S APPROVED WIRING DIAGRAMS, DETAILS, AND INSTRUCTIONS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PROVIDE MATERIAL AND EQUIPMENT COMPATIBLE WITH EQUIPMENT ACTUALLY SUPPLIED.
29. DO NOT COMBINE DIFFERENT SYSTEM VOLTAGES IN SAME CONDUIT (EG., 120/208V VS. 277/480V), UNLESS APPROVED BY ENGINEER OR SHOWN ON DRAWINGS.
30. ELECTRICAL SYSTEMS SHALL BE INSTALLED FOR FINAL INSPECTIONS. PROVIDE NEUTRAL TEST AND PROOF OF TORQUE DURING FINAL INSPECTION FOR ALL UNITS. FINAL TERMINATIONS OF CONDUCTORS TO ELECTRICAL EQUIPMENT AND DEVICES SHALL BE TORQUE WRENCH TIGHTENED TO THE MANUFACTURER'S RECOMMENDED SPECIFICATION, NO EXCEPTION.
31. CIRCUIT BREAKER TERMINALS IN SWITCHBOARDS AND LOAD CENTER SHALL BE UL LISTED AND APPROVED FOR USE WITH COPPER 75 DEGREE CELSIUS CONDUCTORS.
32. SIZES OF BREAKERS, SWITCHES, FUSES AND FEEDERS ARE BASED ON DESIGNED EQUIPMENT SIZES. THESE SIZES SHALL BE ADJUSTED TO SATISFY REQUIREMENTS OF ACTUAL INSTALLED OR SUBSTITUTE EQUIPMENT. UP SIZING OR DOWNSIZING OF FEEDERS SHALL BE PROVIDED WITHOUT ADDITIONAL COST TO THE OWNER.
33. AS REQUIRED ALL OVERSIZED FEEDERS THAT WERE ADJUSTED IN SIZE TO COMPENSATE FOR VOLTAGE DROP SHALL BE PROVIDED WITH ADAPTER LUGS OR SPLICE BOX. ADAPTER LUGS SHALL BE PROVIDED IF SIZE IS AVAILABLE. OTHERWISE PROVIDE CABLE SPLICES IN THE SPLICE BOX TO REDUCE CABLES TO THE MAXIMUM SIZE THAT THE BREAKER LUGS CAN ACCOMMODATE.
34. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL SAW–CUTTING, TRENCHING, BACKFILLING, COMPACTION AND PATCHING OF CONCRETE AND ASPHALT AS REQUIRED TO COMPLETE WORK. USE EXTREME CAUTION WHEN TRENCHING NEAR EXISTING UNDERGROUND UTILITY LINES. CONTRACTOR SHALL PROVIDE ALL REQUIRED CUTTING, PATCHING, PAINTING, AND REPAIRS NECESSARY TO RESTORE DAMAGED SURFACES TO EQUAL OR BETTER THAN ORIGINAL CONDITIONS EXISTING AT THE START OF WORK.
35. ALL ELECTRICAL EQUIPMENT SHALL BE BRACED OR ANCHORED TO RESIST HORIZONTAL FORCE ACTING IN ANY DIRECTION IN ACCORDANCE WITH THE REQUIREMENTS OF THE LATEST EDITION OF ASCE7.
36. ALL INTERIOR AND ABOVE GRADE EXTERIOR CONDUIT INSTALLATION SHALL BE RIGID GALVANIZED STEEL, UNLESS EXCEPTED BY NOTE 37 BELOW.
37. ELECTRICAL METALLIC TUBING (EMT) MAY BE USED IN THE FOLLOWING CONDITIONS: INTERIOR APPLICATIONS, SMALLER THAN 2" TRADE SIZE DIAMETER AND INSTALLED EIGHT (8) FEET FROM FINISHED FLOOR OR HIGHER, OR INTERIOR APPLICATIONS, SMALLER THAN 2" TRADE SIZE DIAMETER AND ENTERING A PANEL FROM ABOVE.
38. CONNECTIONS TO VIBRATING EQUIPMENT (MOTOR, TRANSFORMER ENCLOSURE, ETC.) AND SEISMIC SEPARATIONS SHALL BE PROVIDED WITH LIQUID–TIGHT FLEXIBLE STEEL CONDUIT WITH WATERTIGHT CONNECTORS. MAXIMUM LENGTH OF CONDUIT SHALL BE SIX FEET, UNLESS OTHERWISE NOTED.
39. POLYVINYL CHLORIDE (PVC) SCHEDULE 40 MAY BE INSTALLED BENEATH SLAB AND UNDERGROUND INSTALLATION. INSTALL PVC COATED RIGID STEEL CONDUIT FOR TRANSITION FROM UNDERGROUND TO ABOVE GRADE INSTALLATION.
40. CONTRACTOR SHALL PROVIDE TERMINATIONS FOR ALL DATA/VOICE CABLES INDICATED AT OUTLET LOCATIONS INDICATED ON DRAWINGS.
41. CONTRACTOR SHALL PROVIDE AND INSTALL ACCESS PANELS IN NON–ACCESSIBLE CEILINGS WHERE REQUIRED TO ACCESS ELECTRICAL EQUIPMENT IN CEILING SPACE. ACCESS DOORS SHALL HAVE FIRE RATING EQUAL TO THE CEILING ASSEMBLY IN WHICH THEY ARE INSTALLED.
42. ALL FIRE LIFE SAFETY EQUIPMENT, SUCH AS FIRE ALARM CONTROL PANEL AND REMOTE POWER SUPPLIES SHALL BE PROVIDED WITH DEDICATED CIRCUITS. IDENTIFY CIRCUIT DESIGNATION AND PROVIDE PERMANENT LABELING, "FIRE ALARM CIRCUIT" ON ELECTRICAL PANEL. PROVIDE LOCKABLE CIRCUIT BREAKER.
43. CONTROL CONDUIT FOR ENERGY/BUILDING MANAGEMENT SYSTEM (E/BMS) SHALL BE PROVIDED AND INSTALLED BY ELECTRICAL CONTRACTOR.
44. ROUTE CONDUIT PARALLEL AND PERPENDICULAR TO WALLS AND ADJACENT PIPING. ARRANGE CONDUIT TO MAINTAIN HEADROOM AND TO PRESENT A NEAT APPEARANCE.
45. WHEN A DISCREPANCY IN QUANTITY OR SIZE OF CONDUIT, WIRE, EQUIPMENT, CIRCUIT BREAKERS, ETC., ARISES ON THE DRAWINGS OR SPECIFICATIONS, CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AND INSTALLING ALL MATERIAL REQUIRED BY THE MOST STRINGENT CONDITIONS NOTED ON THE DRAWINGS OR IN THE SPECIFICATIONS TO PROVIDE A COMPLETE AND OPERABLE SYSTEM, OR AS DIRECTED BY ENGINEER.
46. FOR SMALL AC MOTORS NOT HAVING BUILT–IN THERMAL OVERLOAD PROTECTION, PROVIDE MANUAL MOTOR STARTERS WITH OVERLOAD HEATER ELEMENTS SIZED PER MANUFACTURER'S RECOMMENDATION. FOR SMALL AC MOTORS WITH BUILT–IN THERMAL OVERLOAD PROTECTION, PROVIDE A HORSEPOWER RATED TOGGLE DISCONNECT SWITCH.
47. DISCONNECT SAFETY SWITCHES SHALL BE HEAVY DUTY AND BE RATED FOR THE NUMBER OF POLES, VOLTAGE, CURRENT AND HORSEPOWER RATING AS REQUIRED. PROVIDE FUSE PROTECTION BASED ON THE MOTOR NAMEPLATE RATINGS.
48. PROVIDE PERMANENT IDENTIFICATION (NAMEPLATES) FOR ALL ELECTRICAL PANELS, SWITCHBOARDS, MOTOR CONTROL CENTERS, DISCONNECT SWITCHES, TRANSFORMERS, TERMINAL CABINETS, ETC.
49. ELECTRICAL CONTRACTOR IS RESPONSIBLE TO VERIFY TYPE OF CEILING SYSTEMS AND TO FURNISH APPROVED LIGHTING FIXTURES OF THE TYPE REQUIRED FOR MOUNTING IN SUBJECT CEILING. PROVIDE ALL NECESSARY MOUNTING KIT/HARDWARE TO PROVIDE A COMPLETE WORKING LIGHTING SYSTEM.
50. ALL FINAL ELECTRICAL CONNECTIONS TO OWNER FURNISHED EQUIPMENT SHALL BE MADE BY THE ELECTRICAL CONTRACTOR.
51. ALL SPLICES AND TERMINALS SHALL BE COMPRESSION TYPE, OF SEAMLESS PURE COPPER, TIN PLATED, LONG BARREL, INSPECTION WINDOW, TERMINALS WITH TWO–HOLE PAD (WITH NEMA DRILLING). CLEAN ALL SURFACES AND INSTALL WITH OXIDE INHIBITING COMPOUND BURNDY PENETROX–E OR EQUAL. APPLY COMPOUND BETWEEN BUS BAR AND LUG PAD AND BETWEEN CONDUCTOR AND LUG BARREL. INSTALL COMPRESSION CONNECTORS WITH A FULLY CIRCUMFERENTIAL COMPRESSION DIE BURNDY HYPRESS OR EQUAL.
52. LABEL ALL CONDUIT WHERE IT BEGINS, AND WHERE IT TERMINATES INTO A BOX, PANEL, DEVICE, LOAD, OR DISCONNECT. CONDUIT SHALL BE LABELED EVERY 30 FEET OR LESS. CONDUIT SHALL BE LABELED WHERE IT PENETRATES ANY WALL OR FLOOR. LABEL SHALL BE PERMANENT PRINTED LABELS (DESCRIBING SOURCE, CIRCUIT, AND LOAD) LEGIBLE FROM FLOOR WHERE POSSIBLE (STANDING POSITION).
53. CONTRACTOR'S FAILURE TO ORDER OR RELEASE ORDER FOR MATERIALS AND/OR EQUIPMENT WILL NOT BE ACCEPTED AS A REASON TO SUBSTITUTE ALTERNATE MATERIALS, EQUIPMENT OR INSTALLATION METHODS.
54. PROVIDE ARC–FLASH HAZARD WARNING LABELS ON ALL AFFECTED ELECTRICAL EQUIPMENT, INCLUDING SWITCHBOARDS, PANEL BOARDS, INDUSTRIAL CONTROL PANELS, METER SOCKET ENCLOSURES, AND MOTOR CONTROL CENTERS. MARKING SHALL BE LOCATED SO AS TO BE CLEARLY VISIBLE TO QUALIFIED PERSONS. LABEL SHALL BE FACTORY PRE–PRINTED OR MACHINE–PRINTED SELF–ADHESIVE VINYL MATERIAL; UV, CHEMICAL, WATER, HEAT AND ABRASION RESISTANT; PRODUCED USING MATERIALS RECOGNIZED BY UL 969. MINIMUM SIZE: 3.5 BY 5 INCHES.
55. UNLESS OTHERWISE NOTED, ARRANGE, PAY FOR, COORDINATE AND PROVIDE ALL PERMITS NECESSARY FOR A COMPLETE AND OPERABLE SYSTEM.
56. ALL WORK IS <N> UNLESS OTHERWISE NOTED.
57. ELECTRICAL CONDUCTORS SERVING EQUIPMENT SUPPLIED BY POWER CONVERSION EQUIPMENT AS PART OF A VARIABLE FREQUENCY DRIVE (VFD) SYSTEM AND/OR A SERVO DRIVE SYSTEM SHALL HAVE THERMOSET INSULATION TYPE XHHW, OR XHHW–2

SYMBOLS & ABBREVIATIONS

SYMBOL	DESCRIPTION
	EXTENT OF DEMOLITION
	NEW TO EXISTING CONNECTION
1	WORK ITEM (ELECTRICAL)
1 / E-5.1	DETAIL DESIGNATION — DETAIL NUMBER; DRAWING NUMBER (IF BLANK, SAME SHEET)
CT / 1	EQUIPMENT DESIGNATION — EQUIPMENT TYPE; EQUIPMENT NUMBER
1 / E-5.1	SECTION DESIGNATION — SECTION NUMBER; DRAWING NUMBER (IF BLANK, SAME SHEET)
	EXISTING CONDUIT
	NEW CONDUIT
	CONDUIT TO BE DEMOLISHED
	PANEL BOARD/TERMINAL CABINET – FLUSH/SURFACE MOUNTED
	BRANCH CIRCUIT WIRING IN CONDUIT CONCEALED IN CEILING SPACE OR WHERE POSSIBLE, EXPOSED ON ROOF OR BUILDING EXTERIOR.
	BRANCH CIRCUIT WIRING IN CONDUIT CONCEALED UNDER FLOOR, UNDERGROUND OR WHERE POSSIBLE.
*	BRANCH CIRCUIT HOME RUN TO PANEL. CONCEALED IN CEILING SPACE OR WHERE POSSIBLE. *= PANEL BOARD & CIRCUIT #
	EXISTING DEVICES, CONDUITS, WIRES, ETC TO REMAIN
	NEW (BOLD) DEVICES, CONDUITS, WIRES, ETC.
	CONDUIT UP
	CONDUIT DOWN
	WALL MOUNTED DUPLEX RECEPTACLE 20A, 125V, 3WG, NEMA 5–20R, +18"AFF
C	WALL MOUNTED DUPLEX CONTROL RECEPTACLE
WP GFI	DUPLEX GFI RECEPTACLE, WEATHERPROOF, 20A, 165V, 3WG, NEMA 5–20R, GFI
	WALL–MOUNTED DOUBLE DUPLEX RECEPTACLE 20A, 125V, 3WG, (2) NEMA 5–20R, +18" UON
	SPECIAL RECEPTACLE (TYPE AND CONFIGURATION AS NOTED)
	(1) RJ–45 DATA OUTLET (1) RJ–11 VOICE OUTLET W/ FACE PLATE
	(1) RJ–45 DATA OUTLET – CEILING
	CEILING–MOUNTED DUPLEX RECEPTACLE 20A, 125V, 3WG, NEMA 5–20R
	CEILING–MOUNTED DOUBLE DUPLEX RECEPTACLE 20A, 125V, 3WG, (2) NEMA 5–20R
	FLOOR–MOUNTED DUPLEX RECEPTACLE 20A, 125V, 3WG, NEMA 5–20R
	(1) RJ–45 DATA OUTLET (1) RJ–11 VOICE OUTLET W/ FACE PLATE } FLOOR MOUNTED
PP	POWER POLE
MM	MULTI MEDIA RECEPTACLE
J, J, J	JUNCTION BOX – CEILING/FLOOR/ROOF/WALL MOUNTED
T	TRANSFORMER
$a	DIMMER SWITCH, LOWER CASE LETTER INDICATES CIRCUIT CONTROLLED BY SWITCH, +44" AFF.
OS	DUAL TECHNOLOGY OCCUPANCY SENSOR – CEILING
RC	DIMMING ROOM CONTROLLER
PC	DAYLIGHT PHOTO SENSOR – CEILING
NB	NETWORK BRIDGE
	DISCONNECT SWITCH – NON FUSED
	DISCONNECT SWITCH – FUSED
	DISCONNECT SWITCH & MOTOR STARTER–COMBINATION

ABBREVIATION	MEANING
@	AT
AHJ	AUTHORITY HAVING JURISDICTION
BLDG	BUILDING
C	CONDUIT
CB	CIRCUIT BREAKER
℄	CENTERLINE
CLG	CEILING
CKT	CIRCUIT
C.O.	CONDUIT ONLY (W/PULLROPE)
CONT	CONTINUATION
CSFM	CALIFORNIA STATE FIRE MARSHALL
DLM	DIGITAL LIGHTING MANAGEMENT (WATTSTOPPER)
DN	DOWN
DWG	DRAWING
<E>	EXISTING
ELEC	ELECTRICAL
EM	EMERGENCY
EQ	EQUAL
EQUIP.	EQUIPMENT
<ERR>	EXISTING TO REMAIN AND BE RECONNECTED
<F>	FUTURE
FA	FIRE ALARM
FACP	FIRE ALARM CONTROL PANEL
FATC	FIRE ALARM TERMINAL CABINET
FLR	FLOOR
GFI	GROUND FAULT INTERRUPTER
GND	GROUND
IOR	INSPECTOR OF RECORD
LTG	LIGHTING
LTS	LIGHTS
MAX.	MAXIMUM
MIN.	MINIMUM
<N>	**NEW (BOLD)**
N.T.S.	NOT TO SCALE
PNL	PANEL
<RR>	REMOVE AND RELOCATE
<REL>	RELOCATED
REC	RECEPTACLE
RM	ROOM
RPS	REMOTE POWER SUPPLY
SPB	SIGNAL PULL BOX
SPECS	SPECIFICATIONS
TYP	TYPICAL
TP	TWISTED PAIR (SHIELDED)
U.O.N.	UNLESS OTHERWISE NOTED
V	VOLT
VA	VOLT AMP
V.I.F.	VERIFY IN FIELD
W	WATTS
WP	WEATHERPROOF (NEMA 3R)

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REGISTERED PROFESSIONAL ENGINEER — HUGH L. KING — No. E20539 — ELECTRICAL — STATE OF CALIFORNIA

SOLANO COMMUNITY COLLEGE DISTRICT

SOLANO COMMUNITY COLLEGE

4000 SUISUN VALLEY RD
FAIRFIELD, CA 94534

SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

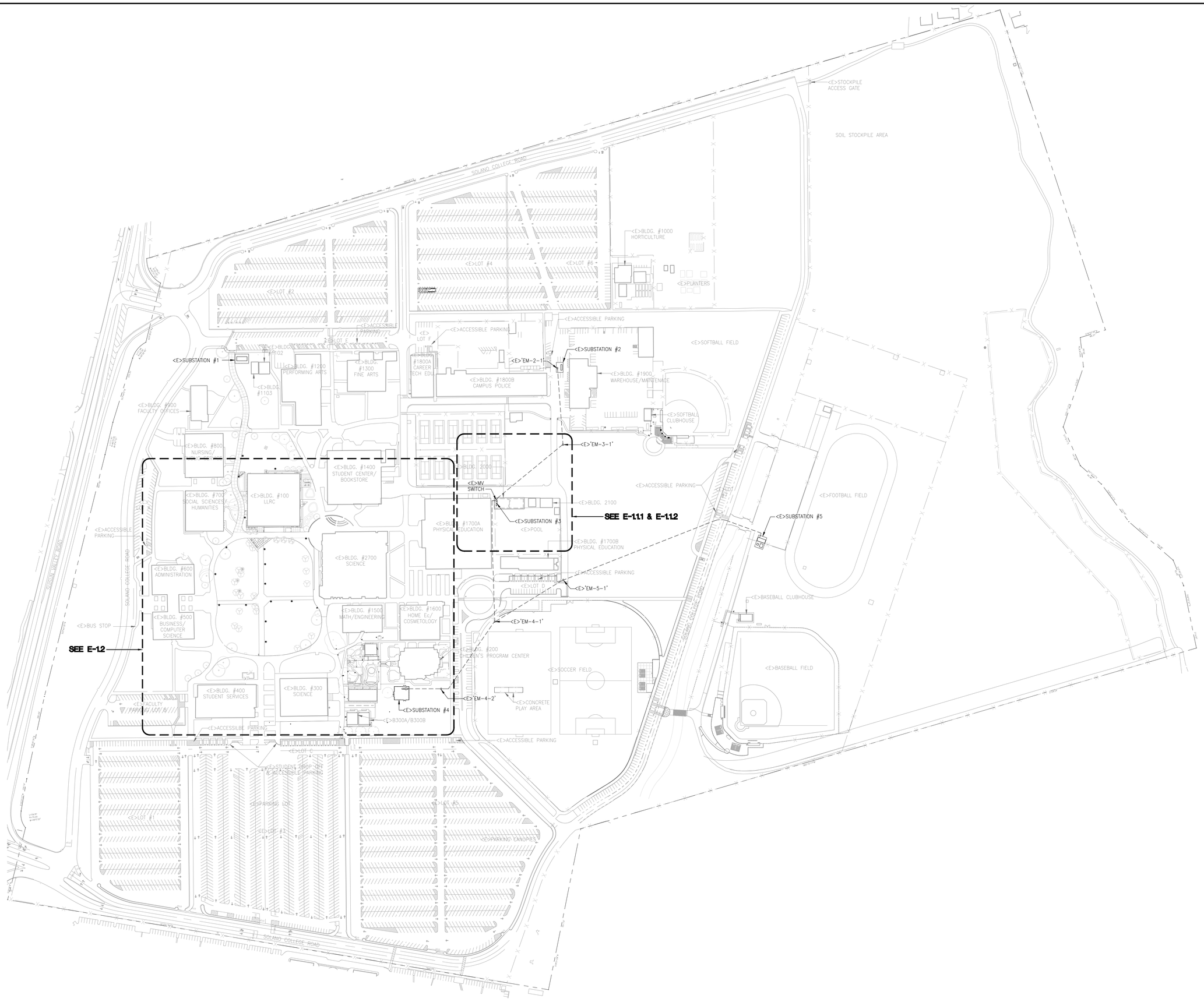
ISSUE		
MARK	DATE	DESCRIPTION
	06/28/22	PROGRESS SET #1
	07/28/22	DESIGN–BUILD DRAWING SET

SOBE PROJECT NO:	2200690
DATE:	07/28/22
DRAWN BY:	
CHECKED BY:	MM
APPROVED BY:	HK

SHEET TITLE
ELECTRICAL GENERAL NOTES, SYMBOLS & ABBREVIATIONS

SCALE: AS NOTED
THIS DRAWING IS 30" X 42" AT FULL SIZE

E–0.1
SHEET OF XX



1 OVERALL SITE PLAN

SCALE: 1" = 120' - 0"

0 120' 240'

N

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SHEET TITLE

ELECTRICAL
OVERALL SITE PLAN

SCALE: AS NOTED
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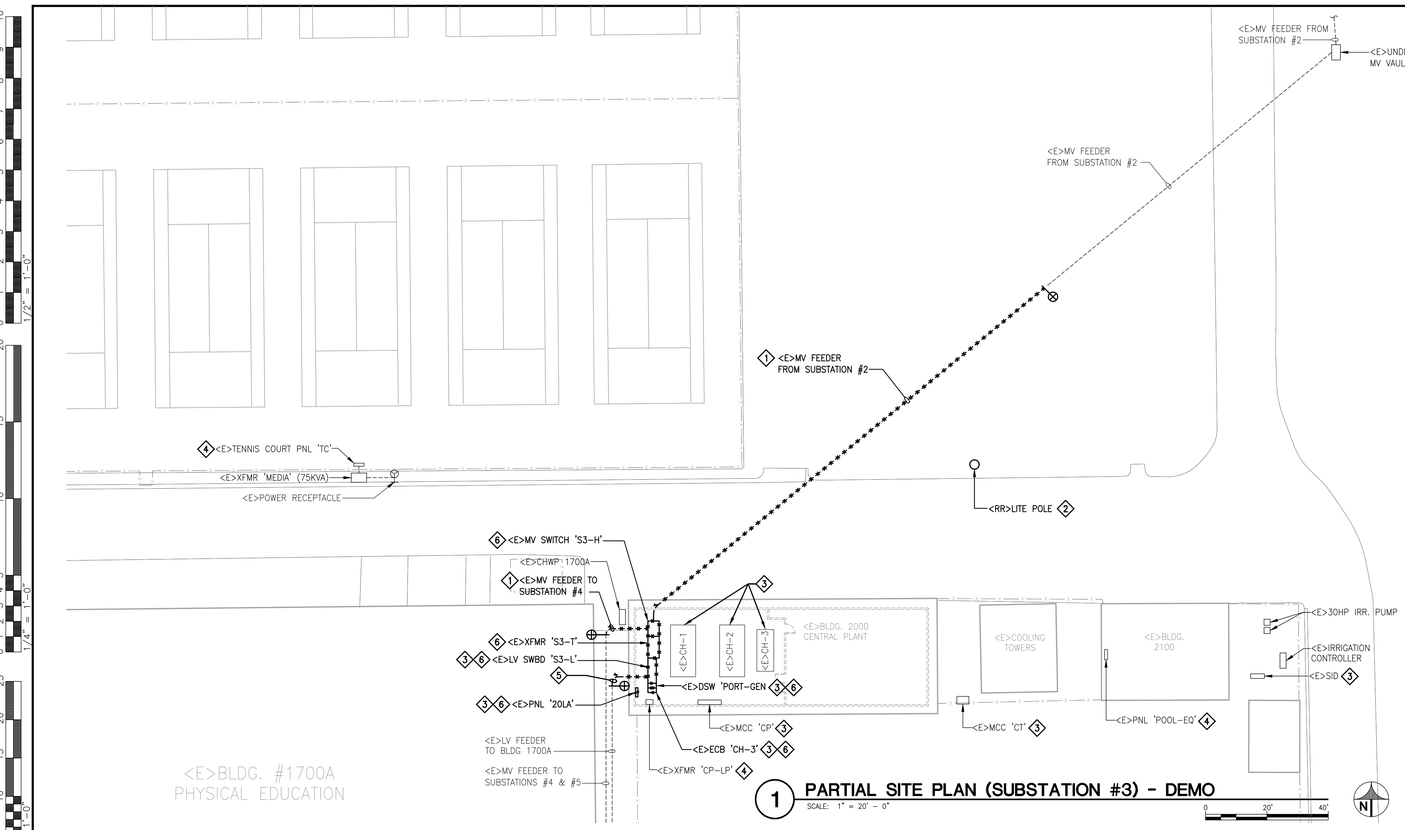
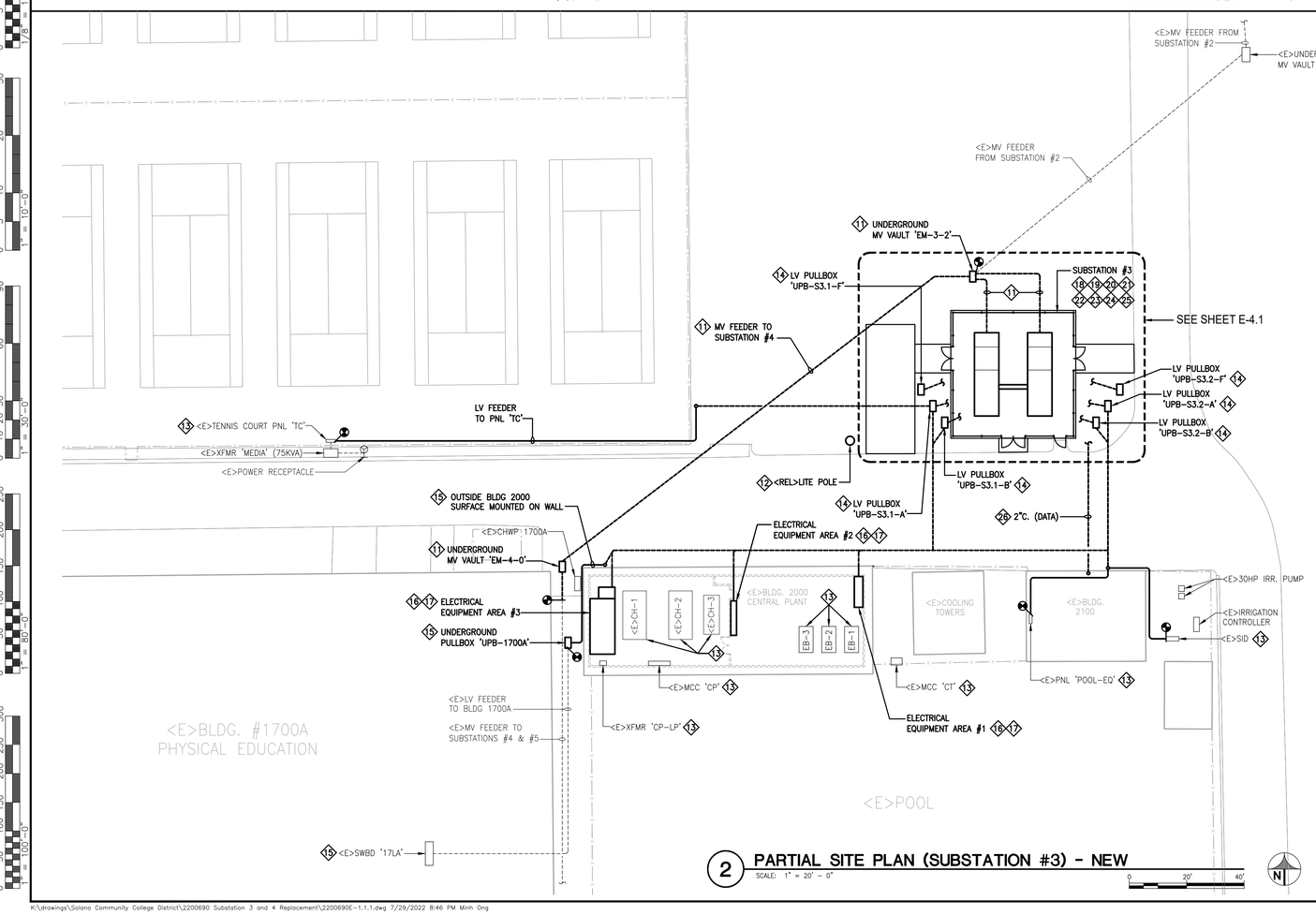
E-1.0

SHEET OF XX



1 PARTIAL SITE PLAN (SUBSTATION #3) - DEMO

SCALE: 1" = 20' - 0"



2 PARTIAL SITE PLAN (SUBSTATION #3) - NEW

SCALE: 1" = 20' - 0"

REFERENCE SHEET NOTES

DEMO:

1. REMOVE EXISTING MV FEEDER AS NECESSARY.
2. RELOCATE EXISTING LIGHTING POLE IF NECESSARY. REFER TO NEW WORK FOR NEW LOCATION.
3. REMOVE EXISTING FEEDERS FROM EXISTING LV SWITCHBOARD 'S3-L' TO FOLLOWING EQUIPMENT:
   - <E> SID
   - <E> MCC 'CT'
   - <E> MCC 'CP'
   - <E> PANEL '20LA'
   - <E> DISCONNECT 'PORT-GEN'
   - <E> CHILLER 'CH-1'
   - <E> CHILLER 'CH-2'
   - <E> ECB 'CH-3' AND CHILLER 'CH-3'
4. REMOVE EXISTING FEEDERS FROM EXISTING PANEL '20LA' TO FOLLOWING EQUIPMENT:
   - <E> POOL EQ PANELBOARD
   - <E> TENNIS COURT PANELBOARD
   - <E> XFMR 'CP-LP'
5. REMOVE EXISTING LV FEEDER FOR SWITCHBOARD '17LA' AS NECESSARY.
6. REMOVE FOLLOWING EQUIPMENT:
   - <E> MV SWITCH 'S3-H'
   - <E> XFMR 'S3-T'
   - <E> LV SWITCHBOARD 'S3-L'
   - <E> DISCONNECT 'PORT-GEN'
   - <E> ECB 'CH-3'
   - <E> PANEL '20LA'

NEW WORK:

11. DESIGN, PROVIDE, AND INSTALL NEW MV FEEDERS, AND CONNECT THEM TO EXISTING MV FEEDER. DESIGN, PROVIDE AND INSTALL FOLLOWING MV VAULTS:
    - <N> EM-3-2
    - <N> EM-4-0
12. PROPOSED NEW LOCATION OF EXISTING LIGHTING POLE.
13. DESIGN, PROVIDE, AND INSTALL NEW FEEDERS FROM FOLLOWING EQUIPMENT TO UPSTREAM SWITCHBOARD/PANELBOARD:
    - <E> SID
    - <E> MCC 'CT'
    - <E> MCC 'CP'
    - <E> CHILLER 'CH-1'
    - <E> CHILLER 'CH-2'
    - <E> CHILLER 'CH-3'
    - <E> POOL EQ PANELBOARD
    - <E> TENNIS COURT PANELBOARD
    - <E> XFMR 'CP-LP'
    - <N> ELECTRIC BOILER 'EB-1'
    - <N> ELECTRIC BOILER 'EB-2'
    - <N> ELECTRIC BOILER 'EB-3'

    REFER TO NEW SINGLE LINE DIAGRAM FOR UPSTREAM SWITCHBOARD/PANELBOARD AND ADDITIONAL INFORMATION.
14. DESIGN, PROVIDE AND INSTALL FOLLOWING UNDERGROUND LV PULL BOXES:
    - <N> UPB-S3.1-A
    - <N> UPB-S3.1-B
    - <N> UPB-S3.1-F
    - <N> UPB-S3.2-A
    - <N> UPB-S3.2-B
    - <N> UPB-S3.2-F

    DESIGN, PROVIDE, AND INSTALL ADDITIONAL UNDERGROUND PULL BOXES IF NECESSARY.
    DESIGN, PROVIDE, AND INSTALL (6) 4" SPARE CONDUITS (FOR FUTURE BREAKERS) FROM <N> LV SWITCHBOARD 'S3.1-L1' TO <N> UPB-S3.1-A AND TO LANDSCAPE AREA (6FT).
    DESIGN, PROVIDE, AND INSTALL (6) 4" SPARE CONDUITS (FOR FUTURE BREAKERS) FROM <N> LV SWITCHBOARD 'S3.2-L1' TO <N> UPB-S3.2-A AND TO LANDSCAPE AREA (6FT).
    REFER TO NEW SINGLE LINE DIAGRAM FOR ADDITIONAL INFORMATION.
15. INTERCEPT AND EXTEND EXISTING FEEDER FOR SWITCHBOARD '17LA' TO NEW SWITCHBOARD 'S3.1-L1' AS NECESSARY. DESIGN, PROVIDE AND INSTALL NEW UNDERGROUND PULL BOX 'UPB-1700A'.
16. DESIGN, PROVIDE, AND INSTALL FOLLOWING EQUIPMENT:
    - <N> MV SWITCH 'S3.1-H'
    - <N> MV SWITCH 'S3.2-H'
    - <N> XFMR 'S3.1-T'
    - <N> XFMR 'S3.2-T'
    - <N> LV SWITCHBOARD 'S3.1-L1'
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.1-L2'
    - <N> LV SWITCHBOARD 'S3.2-L1'
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.2-L2'
    - <N> 5,000A BUS DUCT BETWEEN SWBD 'S3.1-L1' AND SWBD 'S3.2-L1'

    TRANSFORMERS TO BE FROM ZETRAK S.A. DE C.V.:
    CONTACT POWERSYSTEMS GROUP, LLC.
    +1 (682) 307-7380
    EMAIL: robertr@pwrsystemsgroup.com

    USE ELECTRICAL EQUIPMENT AREAS #1, #2, AND #3 FOR FOLLOWING EQUIPMENT:
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.1-L2'
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.2-L2'

    SPLIT/DIVIDE SWITCHBOARDS 'S3.1-L2' AND 'S3.2-L2' INTO SMALLER SWITCHBOARDS/SECTIONS IF SWITCHBOARDS DO NOT FIT IN AVAILABLE SPACE FOR ELECTRICAL EQUIPMENT.
17. DESIGN, PROVIDE, AND INSTALL LV FEEDERS FOR FOLLOWING EQUIPMENT:
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.1-L2'
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.2-L2'
18. DESIGN, PROVIDE, AND INSTALL NEW GROUNDING SYSTEM AS PER NEC – ARTICLE 250.
19. DESIGN, PROVIDE, AND INSTALL NEW REINFORCED CONCRETE PAD.
20. DESIGN, PROVIDE, AND INSTALL NEW FENCE.
21. DESIGN, PROVIDE, AND INSTALL NEW DOUBLE-DOOR GATES (TOTAL OF (3)).
22. DESIGN, PROVIDE, AND INSTALL NEW PERSONNEL GATE.
23. DESIGN, PROVIDE, AND INSTALL NEW LIGHTING SYSTEM.
24. DESIGN, PROVIDE, AND INSTALL NEW CONCRETE DRIVEWAYS (TOTAL OF (3)).
25. DESIGN, PROVIDE, AND INSTALL NEW CONCRETE WALKWAY.
26. DESIGN, PROVIDE, AND INSTALL (1) 2" UNDERGROUND CONDUIT FOR DATA SYSTEM.

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SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

ISSUE MARK	DATE	DESCRIPTION
	06/28/22	PROGRESS SET #1
	07/28/22	DESIGN-BUILD DRAWING SET

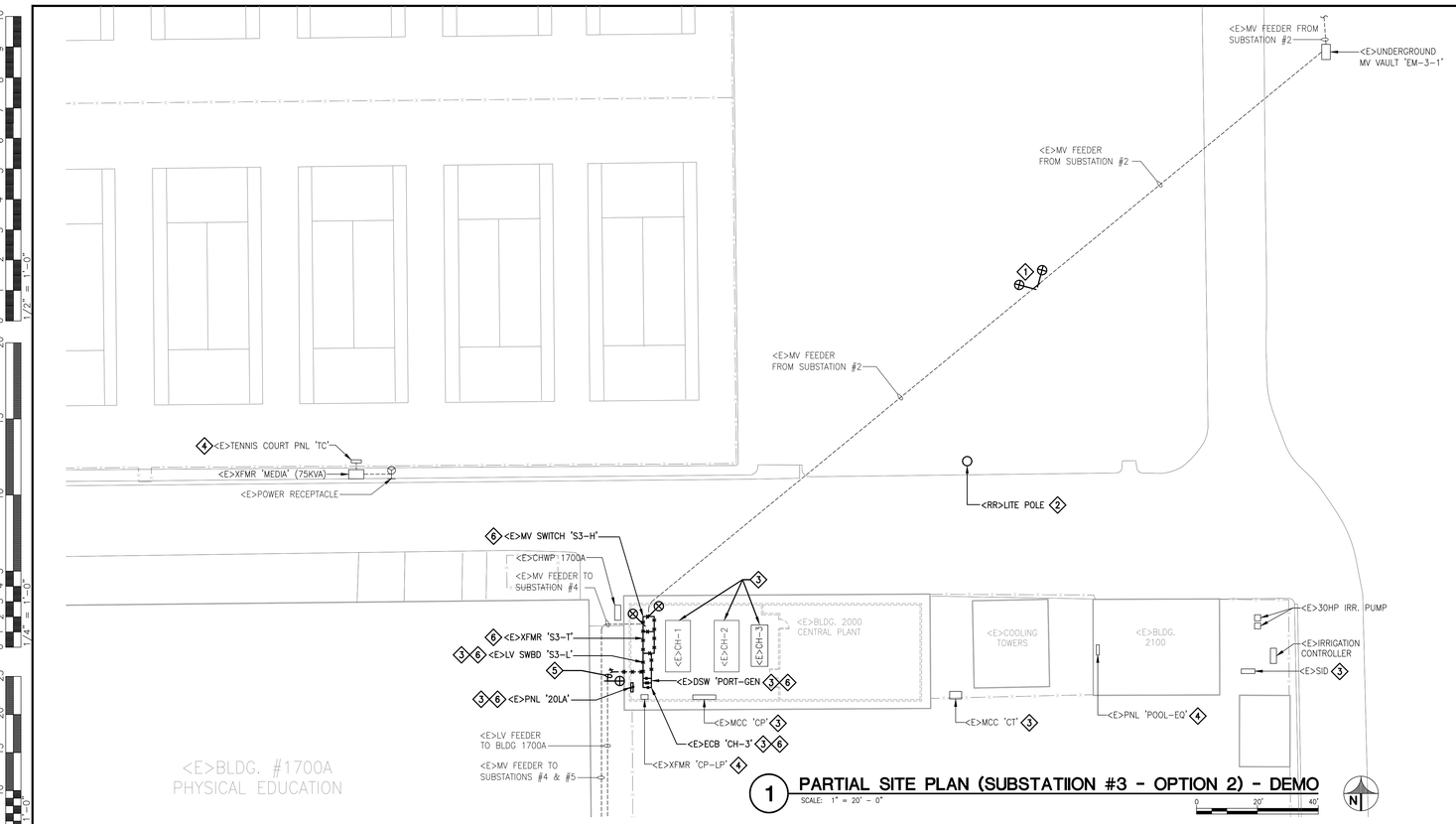
SOBE PROJECT NO:	2200690
DATE:	07/28/22
DRAWN BY:	
CHECKED BY:	MM
APPROVED BY:	HK

SHEET TITLE

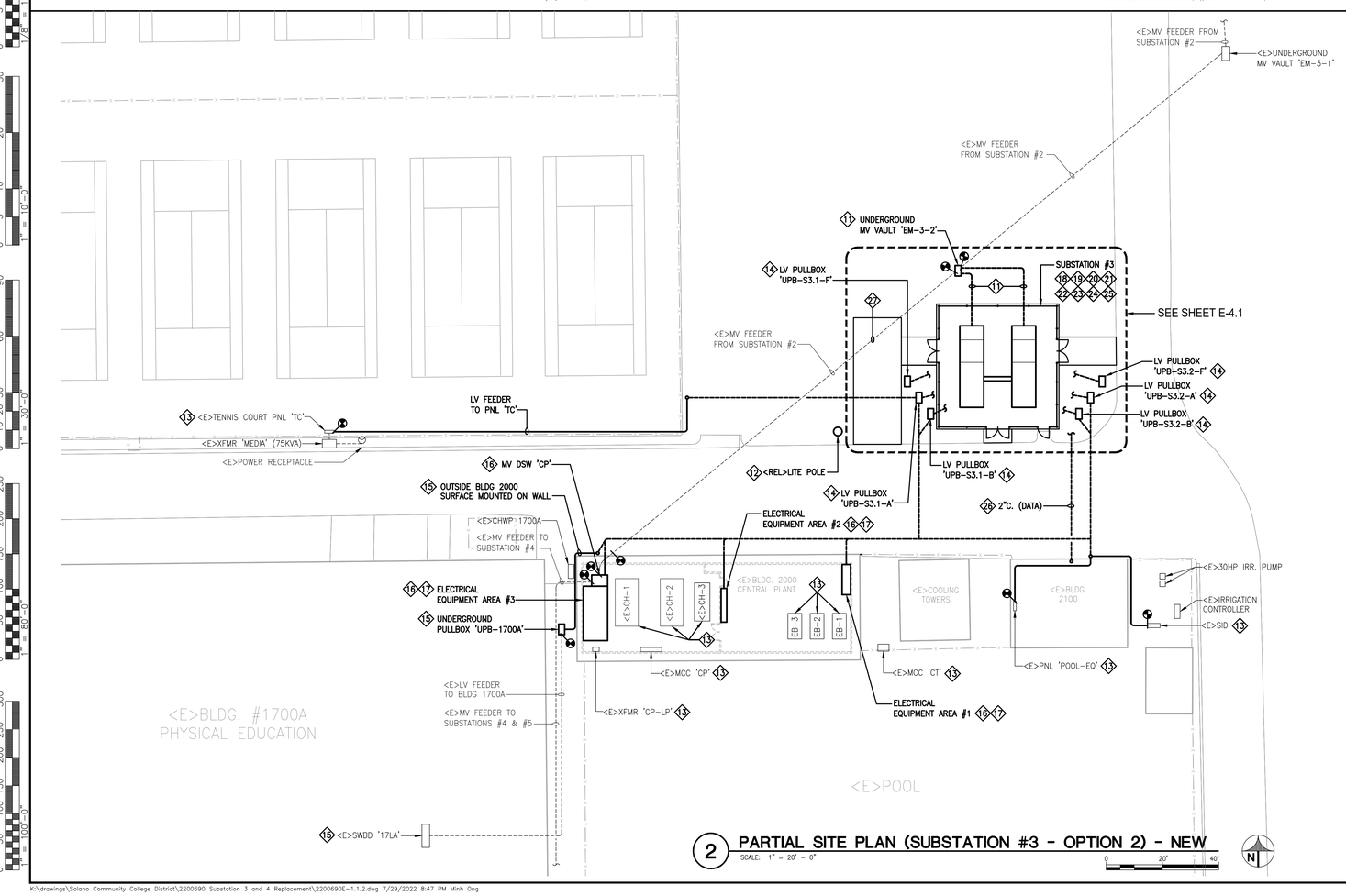
ELECTRICAL PARTIAL SITE PLAN (SUBSTATION #3)

SCALE: AS NOTED
THIS DRAWING IS 30" X 42" AT FULL SIZE

E-1.1.1
SHEET OF XX



1 PARTIAL SITE PLAN (SUBSTATIION #3 - OPTION 2) - DEMO
SCALE: 1" = 20' - 0"



2 PARTIAL SITE PLAN (SUBSTATION #3 - OPTION 2) - NEW
SCALE: 1" = 20' - 0"

REFERENCE SHEET NOTES

DEMO:

1. SPLICE EXISTING MV FEEDER AS NECESSARY.
2. RELOCATE EXISTING LIGHTING POLE IF NECESSARY. REFER TO NEW WORK FOR NEW LOCATION.
3. REMOVE EXISTING FEEDERS FROM EXISTING LV SWITCHBOARD 'S3-L' TO FOLLOWING EQUIPMENT:
   - <E> SID
   - <E> MCC 'CT'
   - <E> MCC 'CP'
   - <E> PANEL '20LA'
   - <E> DISCONNECT 'PORT-GEN'
   - <E> CHILLER 'CH-1'
   - <E> CHILLER 'CH-2'
   - <E> ECB 'CH-3' AND CHILLER 'CH-3'
4. REMOVE EXISTING FEEDERS FROM EXISTING PANEL '20LA' TO FOLLOWING EQUIPMENT:
   - <E> POOL EQ PANELBOARD
   - <E> TENNIS COURT PANELBOARD
   - <E> XFMR 'CP-LP'
5. REMOVE EXISTING LV FEEDER FOR SWITCHBOARD '17LA' AS NECESSARY.
6. REMOVE FOLLOWING EQUIPMENT:
   - <E> MV SWITCH 'S3-H'
   - <E> XFMR 'S3-T'
   - <E> LV SWITCHBOARD 'S3-L'
   - <E> DISCONNECT 'PORT-GEN'
   - <E> ECB 'CH-3'
   - <E> PANEL '20LA'

NEW WORK:

11. DESIGN, PROVIDE, AND INSTALL NEW MV FEEDERS, AND CONNECT THEM TO EXISTING MV FEEDER. DESIGN, PROVIDE AND INSTALL FOLLOWING MV VAULTS:
    - <N> EM-3-2
12. PROPOSED NEW LOCATION OF EXISTING LIGHTING POLE.
13. DESIGN, PROVIDE, AND INSTALL NEW FEEDERS FROM FOLLOWING EQUIPMENT TO UPSTREAM SWITCHBOARD/PANELBOARD:
    - <E> SID
    - <E> MCC 'CT'
    - <E> MCC 'CP'
    - <E> CHILLER 'CH-1'
    - <E> CHILLER 'CH-2'
    - <E> CHILLER 'CH-3'
    - <E> POOL EQ PANELBOARD
    - <E> TENNIS COURT PANELBOARD
    - <E> XFMR 'CP-LP'
    - <N> ELECTRIC BOILER 'EB-1'
    - <N> ELECTRIC BOILER 'EB-2'
    - <N> ELECTRIC BOILER 'EB-3'

    REFER TO NEW SINGLE LINE DIAGRAM FOR UPSTREAM SWITCHBOARD/PANELBOARD AND ADDITIONAL INFORMATION.
14. DESIGN, PROVIDE AND INSTALL FOLLOWING UNDERGROUND LV PULL BOXES:
    - <N> UPB-S3.1-A
    - <N> UPB-S3.1-B
    - <N> UPB-S3.1-F
    - <N> UPB-S3.2-A
    - <N> UPB-S3.2-B
    - <N> UPB-S3.2-F

    DESIGN, PROVIDE, AND INSTALL ADDITIONAL UNDERGROUND PULL BOXES IF NECESSARY.
    DESIGN, PROVIDE, AND INSTALL (6) 4" SPARE CONDUITS (FOR FUTURE BREAKERS) FROM <N> LV SWITCHBOARD 'S3.1-L1' TO <N> UPB-S3.1-A AND TO LANDSCAPE AREA (6FT).
    DESIGN, PROVIDE, AND INSTALL (6) 4" SPARE CONDUITS (FOR FUTURE BREAKERS) FROM <N> LV SWITCHBOARD 'S3.2-L1' TO <N> UPB-S3.2-A AND TO LANDSCAPE AREA (6FT).
    REFER TO NEW SINGLE LINE DIAGRAM FOR ADDITIONAL INFORMATION.
15. INTERCEPT AND EXTEND EXISTING FEEDER FOR SWITCHBOARD '17LA' TO NEW SWITCHBOARD 'S3.1-L1' AS NECESSARY. DESIGN, PROVIDE AND INSTALL NEW UNDERGROUND PULL BOX 'UPB-1700A'.
16. DESIGN, PROVIDE, AND INSTALL FOLLOWING EQUIPMENT:
    - <N> MV SWITCH 'S3.1-H'
    - <N> MV SWITCH 'S3.2-H'
    - <N> XFMR 'S3.1-T'
    - <N> XFMR 'S3.2-T'
    - <N> LV SWITCHBOARD 'S3.1-L1'
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.1-L2'
    - <N> LV SWITCHBOARD 'S3.2-L1'
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.2-L2'
    - <N> 5,000A BUS DUCT BETWEEN SWBD 'S3.1-L1' AND SWBD 'S3.2-L1'
    - <N> MV DISCONNECT SWITCH 'CP'

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    EMAIL: robertr@pwrsystemsgroup.com

    USE ELECTRICAL EQUIPMENT AREAS #1, #2, AND #3 FOR FOLLOWING EQUIPMENT:
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.1-L2'
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.2-L2'

    SPLIT/DIVIDE SWITCHBOARDS 'S3.1-L2' AND 'S3.2-L2' INTO SMALLER SWITCHBOARDS/SECTIONS IF SWITCHBOARDS DO NOT FIT IN AVAILABLE SPACE FOR ELECTRICAL EQUIPMENT.
17. DESIGN, PROVIDE, AND INSTALL LV FEEDERS FOR FOLLOWING EQUIPMENT:
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.1-L2'
    - <N> LV DISTRIBUTION SWITCHBOARD 'S3.2-L2'
18. DESIGN, PROVIDE, AND INSTALL NEW GROUNDING SYSTEM AS PER NEC – ARTICLE 250.
19. DESIGN, PROVIDE, AND INSTALL NEW REINFORCED CONCRETE PAD.
20. DESIGN, PROVIDE, AND INSTALL NEW FENCE.
21. DESIGN, PROVIDE, AND INSTALL NEW DOUBLE-DOOR GATES (TOTAL OF (3)).
22. DESIGN, PROVIDE, AND INSTALL NEW PERSONNEL GATE.
23. DESIGN, PROVIDE, AND INSTALL NEW LIGHTING SYSTEM.
24. DESIGN, PROVIDE, AND INSTALL NEW CONCRETE DRIVEWAYS (TOTAL OF (3)).
25. DESIGN, PROVIDE, AND INSTALL NEW CONCRETE WALKWAY.
26. DESIGN, PROVIDE, AND INSTALL (1) 2" UNDERGROUND CONDUIT FOR DATA SYSTEM.
27. FILED VERIFY DEPTH AND COVER OF EXISTING MV FEEDER UNDER DRIVEWAY, AND DESIGN, PROVIDE, AND INSTALL FEEDER PROTECTION AS PER NEC-300.50 IF NECESSARY.

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SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

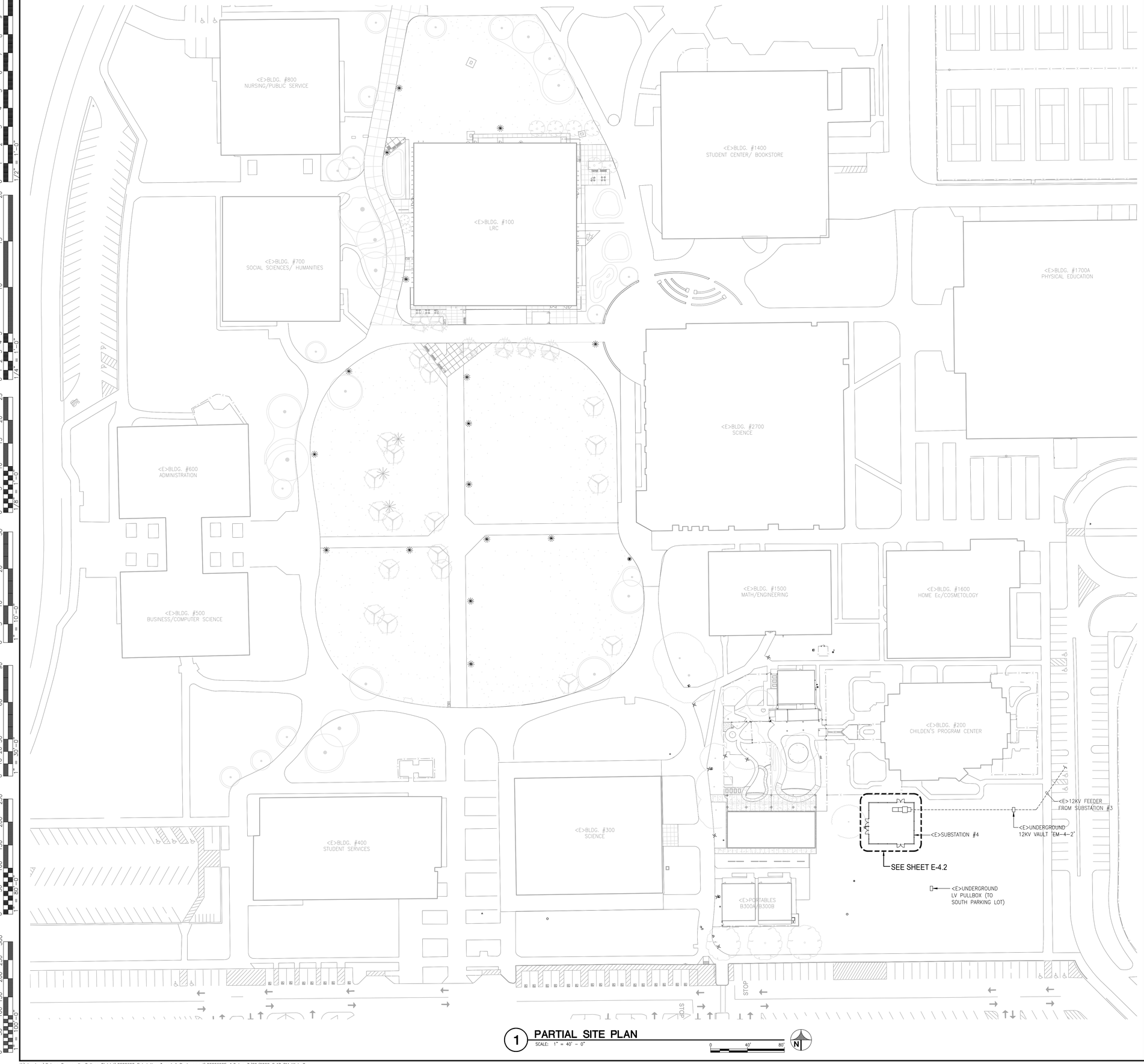
ISSUE MARK	DATE	DESCRIPTION
	06/28/22	PROGRESS SET #1
	07/28/22	DESIGN-BUILD DRAWING SET

SOBE PROJECT NO:	2200690
DATE:	07/28/22
DRAWN BY:	
CHECKED BY:	MM
APPROVED BY:	HK

SHEET TITLE
ELECTRICAL PARTIAL SITE PLAN (SUBSTATION #3 - OPTION 2)

SCALE: AS NOTED
THIS DRAWING IS 30" X 42" AT FULL SIZE

E-1.1.2
SHEET OF XX



1 **PARTIAL SITE PLAN**
SCALE: 1" = 40' - 0"

0 40' 80'

N

K:\drawings\Solano Community College District\2200690 Substation 3 and 4 Replacement\2200690E-1.2.dwg 7/29/2022 8:47 PM Minh Ong

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SUBSTATION #3 & #4 REPLACEMENT

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SHEET TITLE

ELECTRICAL
PARTIAL SITE PLAN
(SUBSTATION #4)

SCALE: AS NOTED
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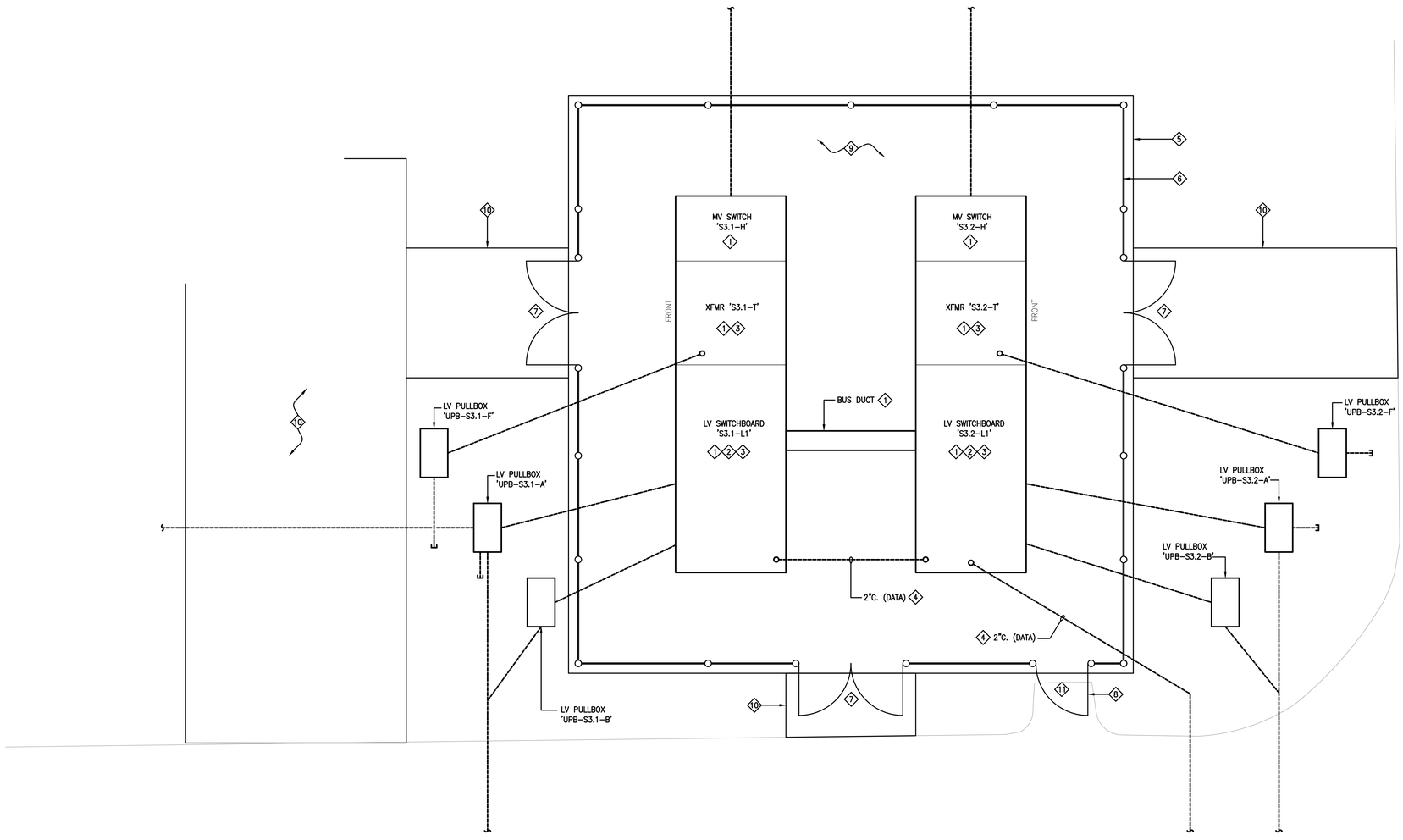
E-1.2
SHEET OF XX



1 **SUBSTATION #3 PLAN**
SCALE: 1/4" = 1'-0"

0 4' 8'

N

REFERENCE SHEET NOTES

1. DESIGN, PROVIDE, AND INSTALL FOLLOWING EQUIPMENT:
   - <N> MV SWITCH 'S3.1-H'
   - <N> MV SWITCH 'S3.2-H'
   - <N> XFMR 'S3.1-T'
   - <N> XFMR 'S3.2-T'
   - <N> LV SWITCHBOARD 'S3.1-L1'
   - <N> LV SWITCHBOARD 'S3.2-L1'
   - <N> 5,000A BUS DUCT BETWEEN SWBD 'S3.1-L1' AND SWBD 'S3.2-L1'

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2. DESIGN, PROVIDE, AND INSTALL LV FEEDERS FOR FOLLOWING EQUIPMENT:
   - <N> LV DISTRIBUTION SWITCHBOARD 'S3.1-L2'
   - <N> LV DISTRIBUTION SWITCHBOARD 'S3.2-L2'
3. DESIGN, PROVIDE, AND INSTALL NEW GROUNDING SYSTEM AS PER NEC – ARTICLE 250.
4. DESIGN, PROVIDE, AND INSTALL (1) 2" UNDERGROUND CONDUIT FOR DATA SYSTEM.
5. DESIGN, PROVIDE, AND INSTALL NEW REINFORCED CONCRETE PAD.
6. DESIGN, PROVIDE, AND INSTALL NEW FENCE.
7. DESIGN, PROVIDE, AND INSTALL NEW DOUBLE-DOOR GATES (TOTAL OF (3)).
8. DESIGN, PROVIDE, AND INSTALL NEW PERSONNEL GATE.
9. DESIGN, PROVIDE, AND INSTALL NEW LIGHTING SYSTEM.
10. DESIGN, PROVIDE, AND INSTALL NEW CONCRETE DRIVEWAYS (TOTAL OF (3)).
11. DESIGN, PROVIDE, AND INSTALL NEW CONCRETE WALKWAY.

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SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

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SHEET TITLE
ELECTRICAL
SUBSTATION #3 PLAN

SCALE: AS NOTED
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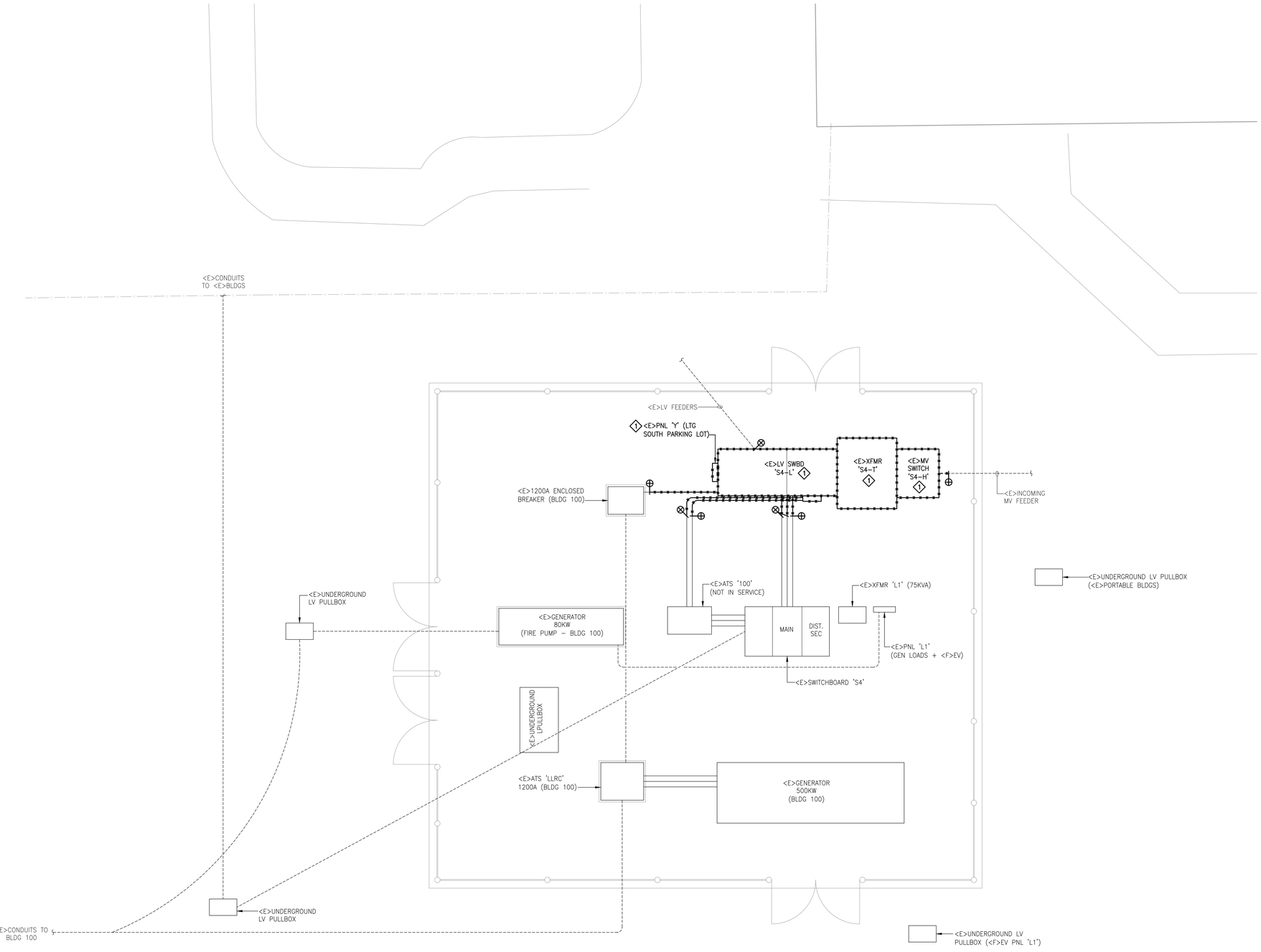
E-4.1
SHEET OF XX



1 SUBSTATION #4 PLAN - DEMO

SCALE: 1/4" = 1' - 0"

0 4' 8'

1 REFERENCE SHEET NOTES

1. REMOVE FOLLOWING EQUIPMENT:
   - <E> MV SWITCH 'S4-H'
   - <E> XFMR 'S4-T'
   - <E> LV SWITCHBOARD 'S4-L'
   - <E> PANEL 'Y' ALONG WITH INCOMING FEEDER

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SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

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DATE:	07/28/22
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CHECKED BY:	MM
APPROVED BY:	HK

SHEET TITLE

ELECTRICAL
SUBSTATION #4 PLAN
DEMO

SCALE: AS NOTED
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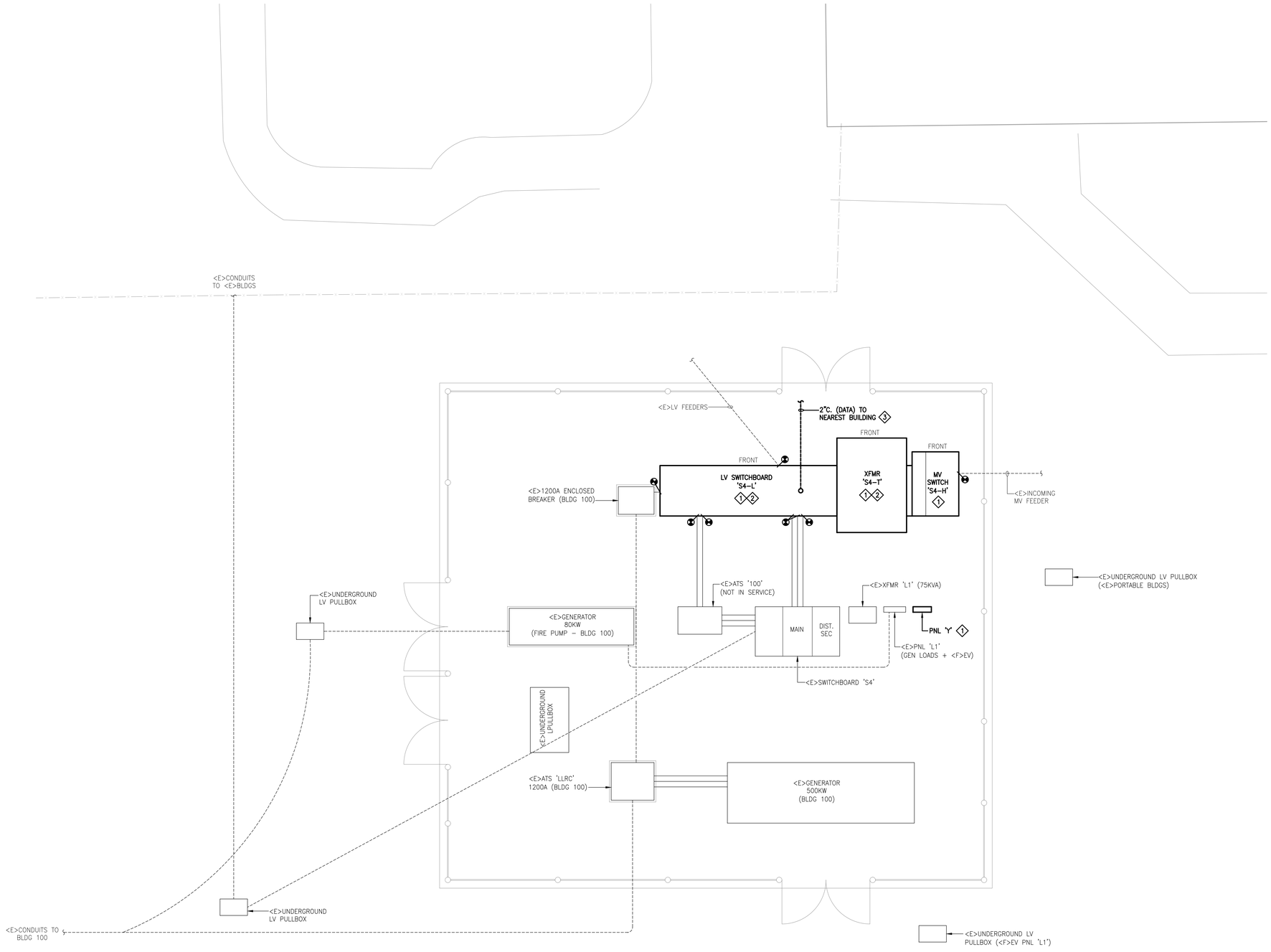
ED-4.2.1

SHEET OF XX



1 SUBSTATION #4 PLAN - NEW

SCALE: 1/4" = 1' - 0"

0 4' 8'

N

REFERENCE SHEET NOTES

1. DESIGN, PROVIDE, AND INSTALL FOLLOWING EQUIPMENT:
   - <N> MV SWITCH 'S4-H'
   - <N> XFMR 'S4-T'
   - <N> LV SWITCHBOARD 'S4-L'
   - <N> PANEL 'Y' ALONG WITH INCOMING FEEDER

   REFER TO SINGLE LINE DIAGRAM FOR ADDITIONAL INFORMATION.

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   EMAIL: robertr@pwrsystemsgroup.com
2. DESIGN, PROVIDE, AND INSTALL NEW GROUNDING SYSTEM AS PER NEC – ARTICLE 250.
3. DESIGN, PROVIDE, AND INSTALL (1) 2" CONDUIT, FOR DATA SYSTEM, TO NEAREST BUILDING.

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SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

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	07/28/22	DESIGN-BUILD DRAWING SET

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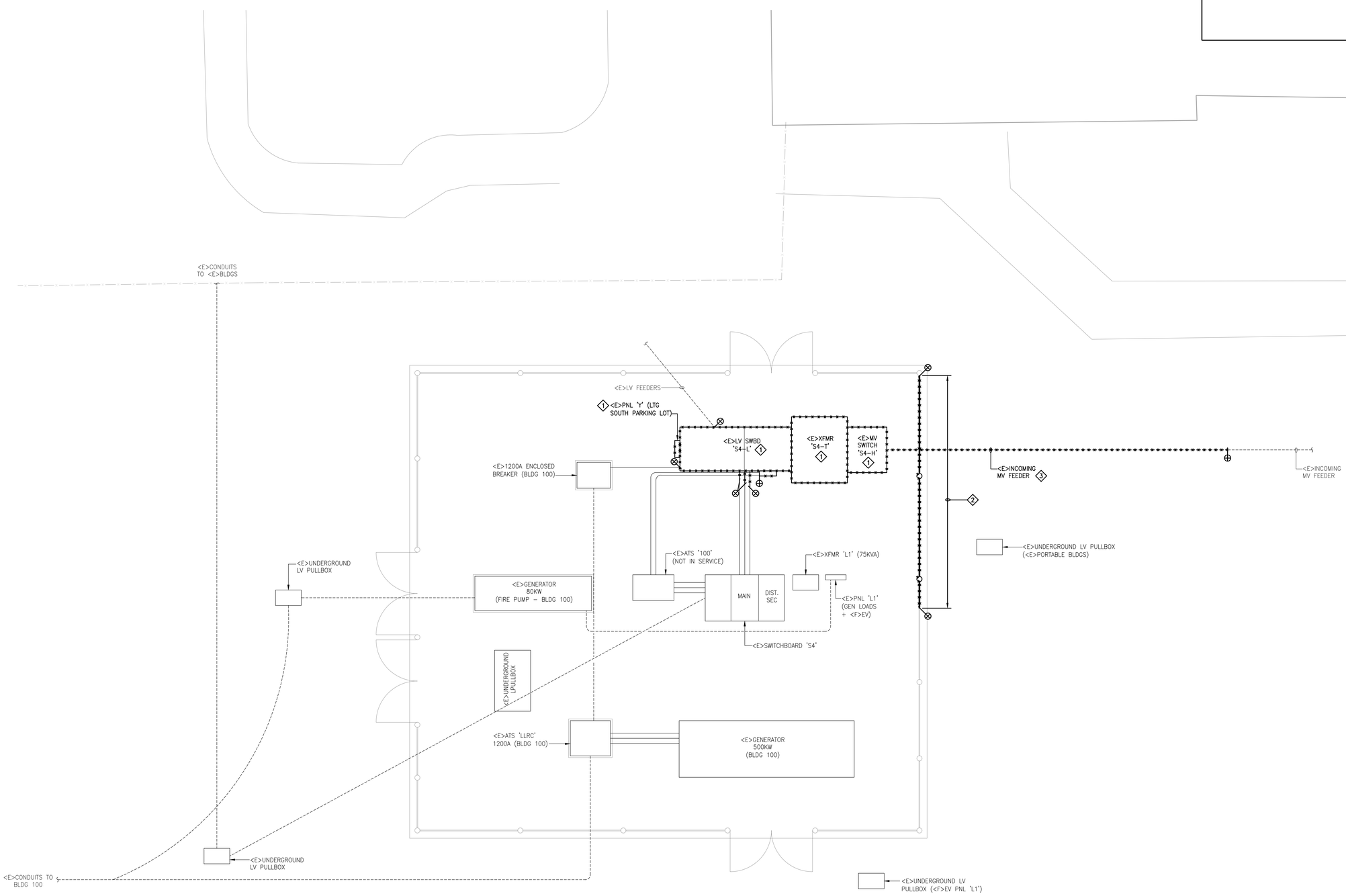
ELECTRICAL
SUBSTATION #4 PLAN
NEW

SCALE: AS NOTED
THIS DRAWING IS 30" X 42" AT FULL SIZE

E-4.2.1
SHEET OF XX

REFERENCE SHEET NOTES

1. REMOVE FOLLOWING EQUIPMENT:
   - <E> MV SWITCH 'S4-H'
   - <E> XFMR 'S4-T'
   - <E> LV SWITCHBOARD 'S4-L'
   - <E> PANEL 'Y' ALONG WITH INCOMING FEEDER
2. REMOVE EXISTING FENCE AS NECESSARY.
3. REMOVE EXISTING INCOMING MV FEEDER AS NECESSARY.



1 SUBSTATION #4 PLAN (OPTION 2) - DEMO
SCALE: 1/4" = 1' - 0"

N

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SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

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	07/28/22	DESIGN-BUILD DRAWING SET

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SHEET TITLE

ELECTRICAL SUBSTATION #4 PLAN (OPTION 2) - DEMO

SCALE: AS NOTED
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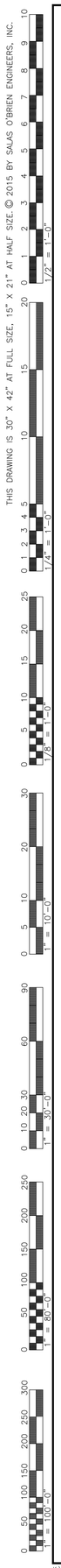
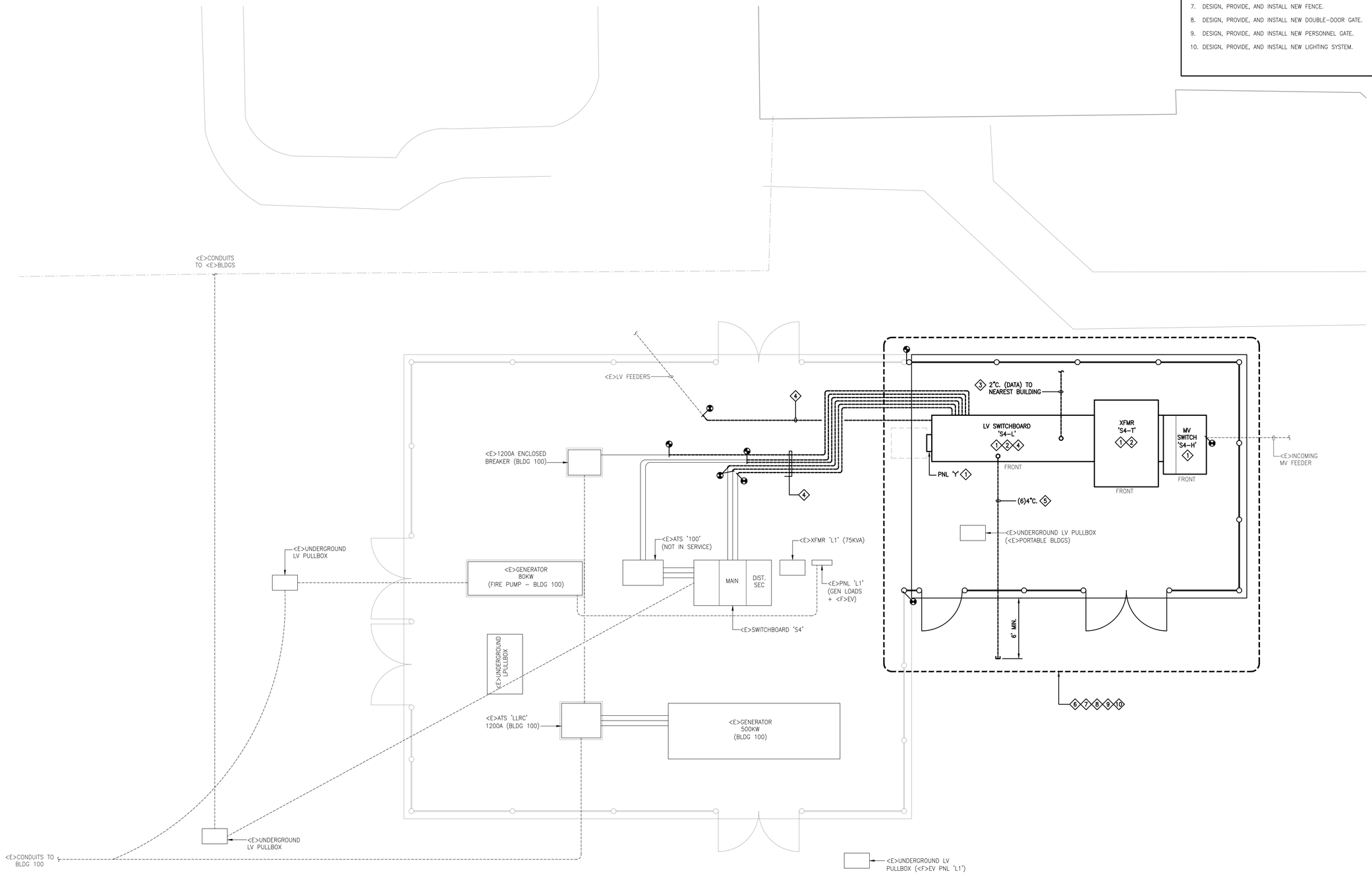
ED-4.2.2
SHEET OF XX





1 SUBSTATION #4 PLAN (OPTION 2) - NEW

SCALE: 1/4" = 1' – 0"

0 4' 8'

N

1 REFERENCE SHEET NOTES

1. DESIGN, PROVIDE, AND INSTALL FOLLOWING EQUIPMENT:
   – <N> MV SWITCH 'S4–H'
   – <N> XFMR 'S4–T'
   – <N> LV SWITCHBOARD 'S4–L'
   – <N> PANEL 'Y' ALONG WITH INCOMING FEEDER
   REFER TO SINGLE LINE DIAGRAM FOR ADDITIONAL INFORMATION.

   TRANSFORMER TO BE FROM ZETRAK S.A. DE C.V.:
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2. DESIGN, PROVIDE, AND INSTALL NEW GROUNDING SYSTEM AS PER NEC – ARTICLE 250.
3. DESIGN, PROVIDE, AND INSTALL (1) 2" CONDUIT, FOR DATA SYSTEM, TO NEAREST BUILDING.
4. EXTEND EXISTING LV FEEDERS TO NEW LV SWITCHBOARD 'S4–L'.
5. DESIGN, PROVIDE, AND INSTALL (6) 4" CONDUITS (FOR FUTURE BREAKERS) FROM NEW LV SWITCHBOARD 'S4–L' TO LANDSCAPE AREA OUTSIDE SUBSTATION #4.
6. DESIGN, PROVIDE, AND INSTALL NEW REINFORCED CONCRETE PAD.
7. DESIGN, PROVIDE, AND INSTALL NEW FENCE.
8. DESIGN, PROVIDE, AND INSTALL NEW DOUBLE–DOOR GATE.
9. DESIGN, PROVIDE, AND INSTALL NEW PERSONNEL GATE.
10. DESIGN, PROVIDE, AND INSTALL NEW LIGHTING SYSTEM.

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SUBSTATION #3 & #4 REPLACEMENT

DSA APPL #XX-XXXXXX

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ELECTRICAL
SUBSTATION #4 PLAN (OPTION 2) - NEW

SCALE: AS NOTED
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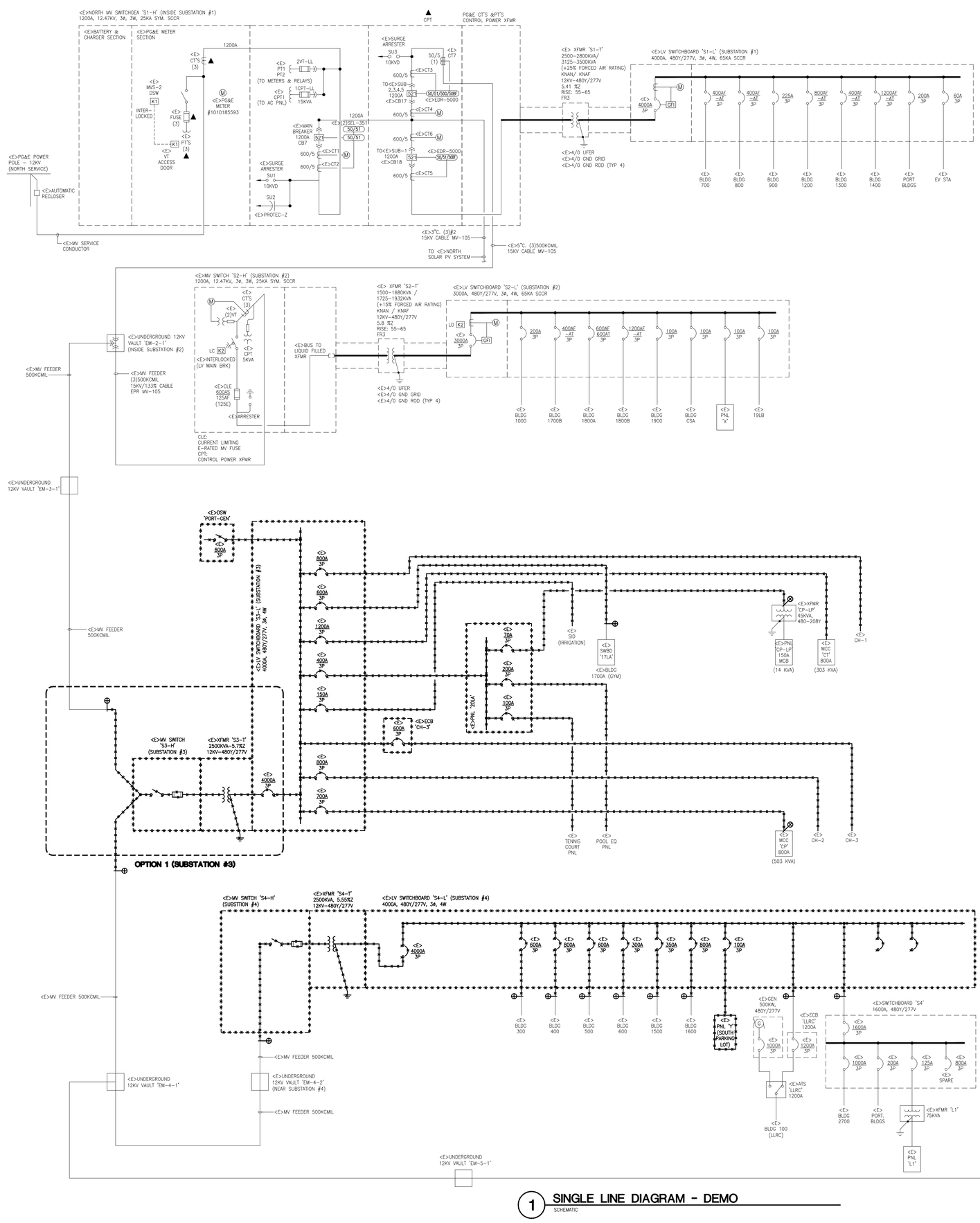
E-4.2.2
SHEET OF XX



1 SINGLE LINE DIAGRAM - DEMO

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SHEET TITLE

ELECTRICAL SINGLE LINE DIAGRAM DEMO

SCALE: AS NOTED

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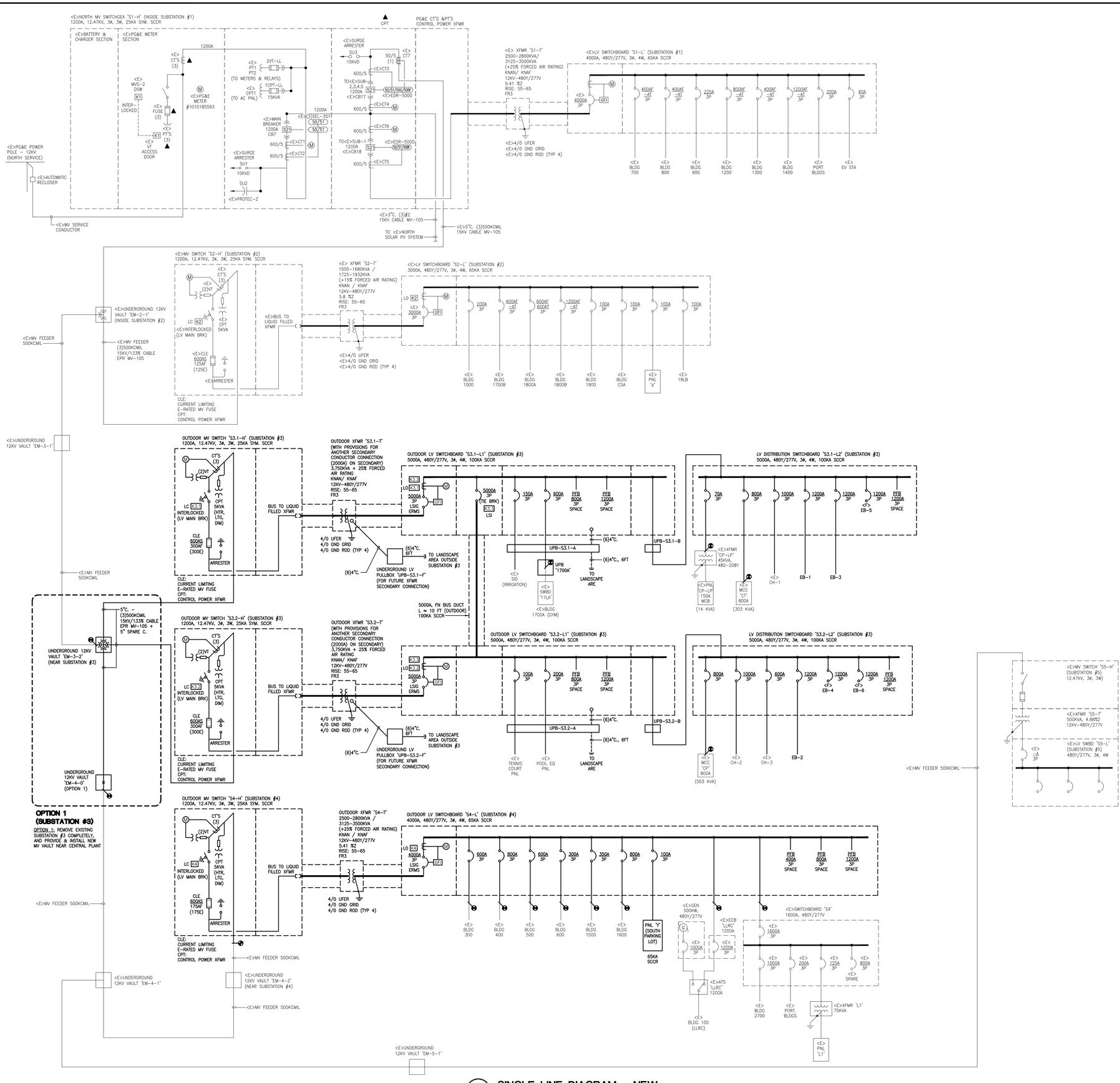
ED-7.1

SHEET OF XX



1 SINGLE LINE DIAGRAM - NEW
SCHEMATIC

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SHEET TITLE
ELECTRICAL SINGLE LINE DIAGRAM NEW

SCALE: AS NOTED
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E-7.1
SHEET OF XX

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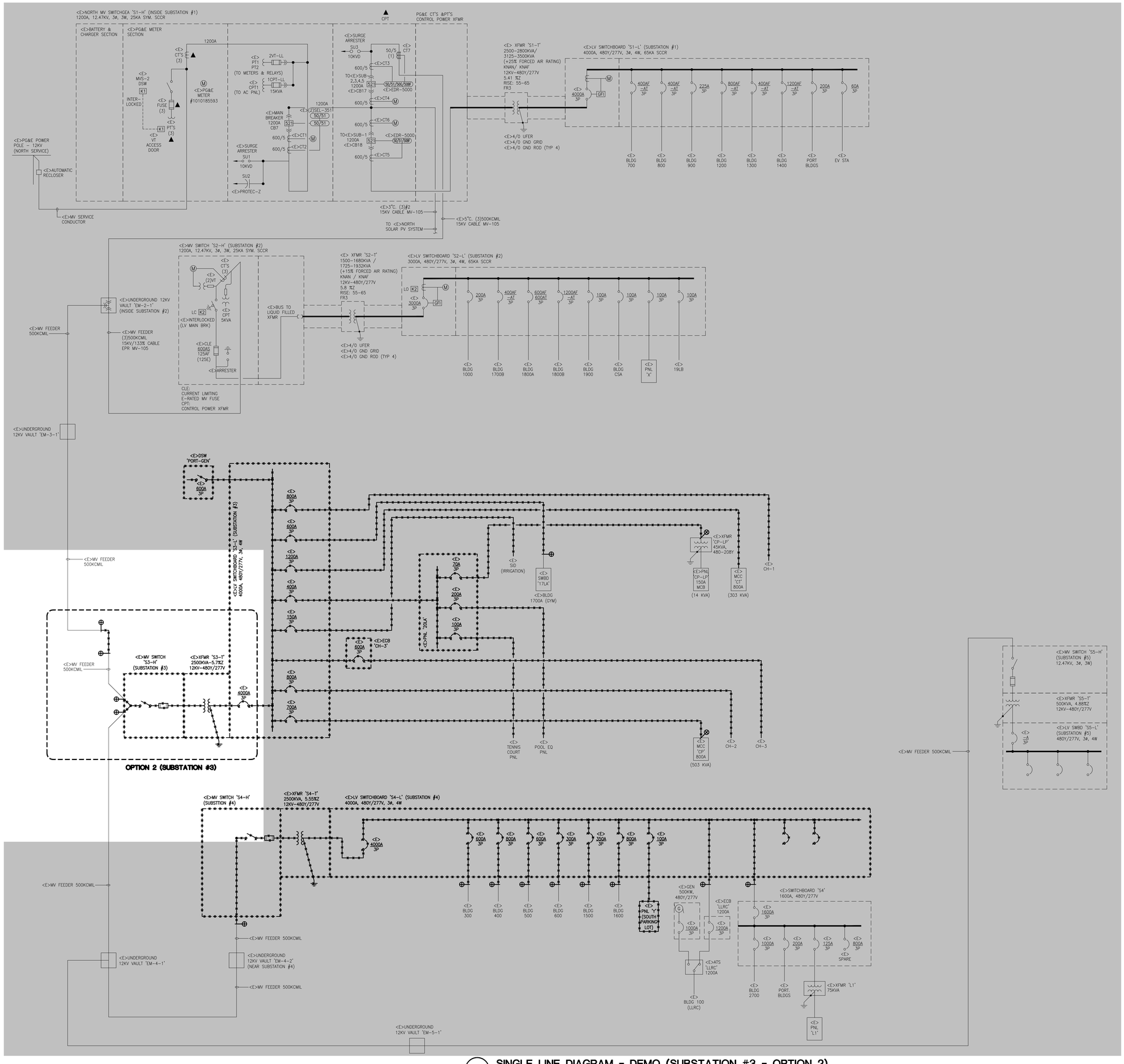

1 SINGLE LINE DIAGRAM - DEMO (SUBSTATION #3 - OPTION 2)
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CHECKED BY:	MM
APPROVED BY:	HK

SHEET TITLE

ELECTRICAL SINGLE LINE DIAGRAM - DEMO (SUBSTATION #3 - OPTION 2)

SCALE: AS NOTED
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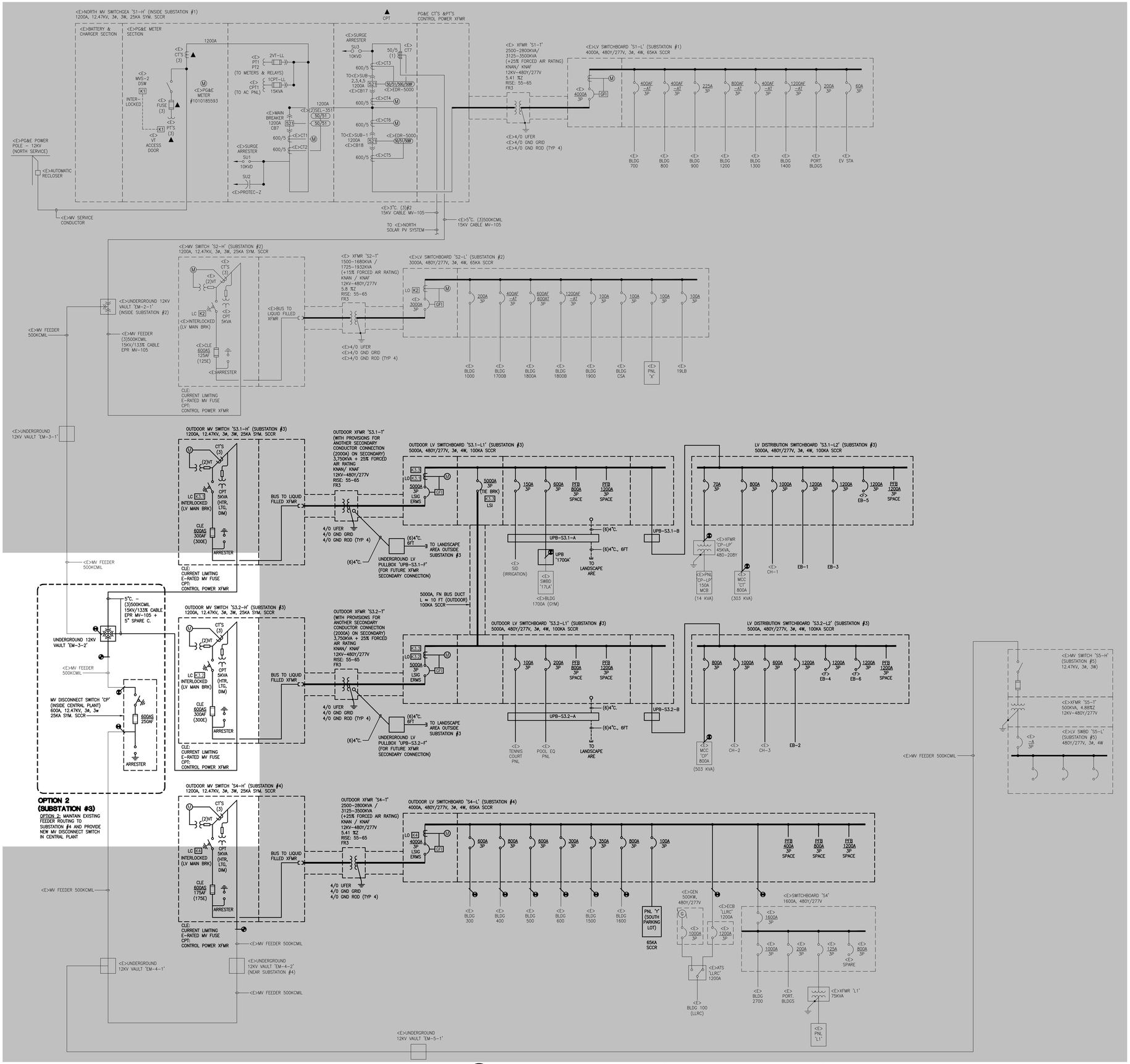
ED-7.2

SHEET OF XX



1 SINGLE LINE DIAGRAM - NEW (SUBSTATION #3 - OPTION 2)

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SHEET TITLE

ELECTRICAL SINGLE LINE DIAGRAM - NEW (SUBSTATION #3 - OPTION 2)

SCALE: AS NOTED

THIS DRAWING IS 30" X 42" AT FULL SIZE

E-7.2

SHEET OF XX