Bid No.030823

PLANS AND SPECIFICATIONS FOR

MARTIN LUTHER KING JR. MIDDLE SCHOOL
COLD BOX ADDITION

FOR

MADERA UNIFIED SCHOOL DISTRICT

601 LILLY ST.
MADERA, CA 93638

LAWRENCE
ENGINEERING GROUP

4910 E. Clinton Way., Suite 101
Fresno, CA 93727
(559) 431-0101

ELECTRICAL CONSULTANT

BORRELLI AND ASSOCIATES, INC.
John Borrelli, E16390
2032 N. Gateway Blvd.
Fresno, CA 93727
(559) 233-4138

STRUCTURAL CONSULTANT

PARRISH HANSEN
Robert Parrish, S2331
418 Clovis Ave.
Fresno, CA 93612
(559) 323-1023

DECEMBER, 2022

PROJECT MANUAL FOR

MARTIN LUTHER KING JR. MIDDLE SCHOOL – COLD BOX ADDITION
MADERA UNIFIED SCHOOL DISTRICT

601 LILLY ST.
MADERA, CA 93638

PREPARED BY:

LAWRENCE ENGINEERING GROUP
CONSULTING MECHANICAL ENGINEERS
7084 NORTH MAPLE AVENUE, SUITE 101
FRESNO, CALIFORNIA 93720

IDENTIFICATION STAMP
DIV. OF THE STATE ARCHITECT
APP: 02-120015 INC:
REVIEWED FOR
SS ☑ FLS ☑ ACS ☑
DATE: 02/14/2023

REGISTERED PROFESSIONAL ENGINEER
RYAN W. CARLSON
No. M34846
Exp. 6-30-24
MECHANICAL
STATE OF CALIFORNIA

MECHANICAL ENGINEER:

REGISTERED PROFESSIONAL ENGINEER
JOHN BORRELL
No.E16390
EXP. 6/30/23
ELECTRICAL
CALIFORNIA

ELECTRICAL ENGINEER:

REGISTERED PROFESSIONAL ENGINEER
ROBERT S. PARRISH
No. S2331
Exp. 3/23
1/24/23
STRUCTURAL
STATE OF CALIFORNIA

STRUCTURAL ENGINEER:

TECHNICAL SPECIFICATIONS – TABLE OF CONTENTS

PART 1 – GENERAL

1.1 SECTION INCLUDES

This section includes general requirements specifically applicable to Division 26, including requirements form Division 1.

1.2 RELATED SECTIONS

A All included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A Standards
  1 AEIC – Association of Edison Illuminating Companies
  2 ANSI – American National Standards Institute
  3 ASTM – American Society of Testing and Materials
  4 CBM – Certified Ballast Manufacturers Association
  5 EIA – Electronic Industry Association
  6 ICEA – Insulated Cable Engineers Association
  7 IEEE – Institute of Electrical and Electronics Engineers
  8 NEMA – The Association of Electrical and Medical Imaging Equipment Manufacturers
  9 FM - Factory Mutual
  10 UL – Underwriter's Laboratory's, Inc., Standards for Safety
B Local codes and authorities having jurisdiction
  1 City codes
  2 County codes
  3 Local fire department
C State codes and authorities having jurisdiction
  1 CBC – California Building Code
  2 CEC – California Electrical Code
  3 State of California Codes
D National codes and authorities having jurisdiction
  1 NESC – National Electrical Safety Code
  2 OSHA – Occupational Safety and Health Act
E Utilities
  1 Local cable company
  2 Local electrical company
  3 Local telephone company
F Code compliance
  1 All work and materials shall comply with the latest rules, codes and regulations, including, but not limited to the following:
    a Occupational Safety and Health Act Standards (OSHA).
    b CCR, Title 24, Part 3: California Electrical Code (CEC)
    c All other applicable Federal, State and Local laws and regulations.
  2 Code compliance is mandatory. Nothing in these Drawings and Specifications permits work not conforming to National, State, and Local electrical and building codes. Where work is shown to exceed minimum code requirements, comply with Drawings and Specifications.
  3 No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, the Contractor shall be responsible for opening the concealed areas, making any required

corrections and/or modifications to his work, and restoring the area to its previous condition.

1.4 DEFINITIONS (APPLICABLE TO DRAWINGS AND SPECIFICATIONS)

A Provide: To supply, install and connect complete and ready for safe and regular operation of particular work referred to unless specifically otherwise noted.
B Install: To erect, mount and connect complete with related accessories.
C Supply: To purchase, procure, acquire and deliver complete with related accessories.
D Work: Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.
E Wiring: Raceway, fittings, wire, boxes, related items and connection.
F Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.
G Exposed: Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms. In general, any item that is directly accessible without removing panels, walls, ceiling or other parts of structure.
H Indicated, Shown, or Noted: As indicated, shown or noted on Drawings or Specifications.
I Above Grade: Not buried in ground and not embedded in concrete slab on ground.
J Below Grade: Buried in ground or embedded in concrete slab on ground.
K Underground: Buried in ground, including under building slabs.
L Connect: Complete hookup of item with required services, including conduit, wire and other accessories.
M Furnish: Supply and deliver complete.
N Similar or Equal: Of base bid manufacturer, equal in materials, weight, size, design, and efficiency of specified product, equivalent to Base Bid Manufacturer's product.
O Reviewed, Satisfactory, Accepted, or Directed: As reviewed, satisfactory, accepted or directed by or to engineer.
P Motor Controllers: Manual or magnetic starters (with or without switches), individual pushbuttons, or hand-off-automatic (HOA) switches controlling the operation of motors.
Q Control Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
R Contractor: Electrical Sub Contractor unless stated otherwise.
S Use (verb): Furnish and install as defined above.

1.5 LICENSES, FEES AND PERMITS

Pay for all City, County or State electrical licenses, fees and permits. Arrange for all required inspections by agencies or authorities having local jurisdiction. The owner shall pay for all inspection fees and permits.

1.6 CONDITIONS AT SITE

A A visit to the site is required of all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
B Underground or overhead lines or other services that are damaged as a result of this work shall promptly be repaired at no expense to the Owner and to complete satisfaction of the Owner.

1.7 DRAWINGS AND SPECIFICATIONS

A All Drawings and all Divisions of these Specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.

B The Contract Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduit and wiring is not assured. Exact requirements shall be governed by architectural, structural and mechanical conditions of the job. Consult all other Drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.

C Right is reserved to make change up to ten (10) feet in location of any outlet, device, or equipment prior to roughing in without increasing contract cost.

D Equipment and fixtures shall be connected to provide circuit continuity in accordance with applicable codes, whether or not each piece of conductor, conduit or protective device is shown between items of equipment or fixtures and the point of circuit origin.

1.8 SAFETY AND INDEMNITY

A Safety: The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours.

B No act, service, Drawing review or construction review by Owner, the Architect, the Engineers or their Consultants, is intended to include review of the adequacy of the Contractor's safety measures, in on or near the construction site.

1.9 RECORD DRAWINGS

A Submit record Drawings under provisions of Section 013000.

B Submit prior to final acceptance inspection, one complete marked-up set of reproducible engineering design Drawings.

1 Fully illustrate revisions made by crafts in course of work.

2 Include field changes, adjustments, variances, substitutions and deletions, including Change Orders.

3 Indicate exact location of raceways, equipment, and devices.

4 Indicate exact size and location of underground and under floor raceways, grounding conductors, and duct banks.

5 The record Drawings shall show all the work actually constructed and originally shown on the Drawing based upon the field construction by the Contractor.

C These Drawings shall be for record purposes for Owner's use and are not considered Shop Drawings.

1.10 MANUFACTURER'S INSTRUCTIONS

A Where the Specifications call for an installation to be made in accordance with manufacturer's recommendations, a copy of such recommendations shall at all times be kept in the job superintendent's office and shall be available to the Owner's representative.

B Follow manufacturer's instructions where they cover points not specifically indicated on Drawings and Specifications. If they are in conflict with the Drawings and Specifications, obtain clarification from the Architect or Engineer before starting work.

C One (1) set of equipment manufacturer's Drawings shall be submitted to the Engineer for their record.

1.11 OPERATING AND MAINTENANCE MANUALS

A Operating and maintenance manuals and close-out documents are used interchangeably

B Submit operating and maintenance manuals of equipment in the following format. Owner shall decide which format they prefer.
1 Three (3) hardcopy sets
2 PDF format

C For specific requirements, see the sections in which the equipment is specified.

1.12 QUALITY ASSURANCE

A Provide a meaningful quality assurance program. To assist the Contractor in this program, the Specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating facility within the scope of this project.

B The Contractor shall insure that workmanship, materials employed, required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

1.13 GUARANTEE

Guarantee the installation free from defects of workmanship and materials for a period of one (1) year after Date of Certificate of final payment and promptly remedy any defects developing during this period, without charge.

1.14 BIDDING

A The contractor shall bid on the plans, specifications, etc. that constitute the contract documents.

B The contractor shall not attempt to modify the contract documents without the approval of the electrical engineer.

C All “value engineering” proposals shall be submitted in to the electrical engineer writing.

D If the contractor makes changes to the contract documents not approved by the electrical engineer, the contractor will still be responsible for installing all devices, conductors, conduits, etc. the contract documents call for.

1.15 ABBREVIATIONS

AIC	Amps interrupting capability
ANSI	American National Standards Institute
ASTM	ASTM International, formerly American Society for Testing and Materials
CAD	Computer aided design
CBC	California Building Code
CEC	California Electrical Code
CFR	Code of Federal Regulations
CMC	California Mechanical Code
CPC	California Plumbing Code
CSFM	California State Fire Marshal
DPDT	Double pole, double throw
DPST	Double pole, single throw
DSA	Division of the State Architect
EIA	Electronic Industries Association
EMT	Electrometallic conduit
EOR	Engineer of record
FMC	Flexible metallic conduit
GRS	Galvanized, rigid steel conduit
HMI	Human machine interface

ICC-ES	International Code Council Evaluation Service
IEEE	Institute of Electrical and Electronic Engineers
IGBT	Insulated Gate Bipolar Transistor
IMC	Intermediate metallic conduit
I/O	Input/output
IOR	Inspector of record
ISO	International Organization for Standardization
LCD	Liquid crystal display
LED	Light emitting diodes
NEC	National Electrical Code
NEMA	Association of Electrical Equipment and Medical Imaging Manufacturers
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NICET	National Institute for Certification in Engineering Technologies
NIST	National Institute of Standards and Technology
OCPD	Overcurrent protection device
PDF	Portable document format
PG&E	Pacific Gas and Electric
PID	Proportional, integral, derivative control
PLC	Programmable logic controller
PQM	Power quality monitor
PVC	Polyvinyl chloride
SCCR	Short circuit current rating
SPD	Surge protective device
SPDT	Single pole, double throw
SPST	Single pole, single throw
TFT	Thin film transistor
THD	Total harmonic distortion
TIA	Telecommunications Industries Association
UL	Underwriters' Laboratories
USB	Universal series bus
UPS	Uninterruptable power supply
VFD	Variable frequency drive
VFD	Vacuum fluorescent display

PART 2 – PRODUCTS

2.1 MATERIAL APPROVAL

A All materials must be new and bear Underwriters' Laboratories label. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency.

B Material not in accordance with these Specifications may be rejected either before or after installation.

C Materials or equipment specified by:

1 Name of manufacturer.

2 Brand or trade name.

3 Catalog reference.

2.2 SUBSTITUTIONS

A Base the bid on use of materials specified.

B Equipment other than specified will be considered for approval provided it meets previous items A through C and the following is submitted in writing by the Contractor to the Engineer to allow approval at least 14 days before the bid date:

1 The request for permission to substitute shall be accompanied with a statement of the amount of money to be returned to the contract if the substitution is permitted.
2 Return a completed request for substitution form.

C The engineer is the sole judge of acceptability of preferred substitutions.

D If a substitute is permitted, and any re design effort is thereby necessitated, the required re design shall be at the Contractor's expense.

2.3 SUBMITTALS

Submit to architect, or engineer if no architect is involved, seven (7) copies of complete Shop Drawings and materials lists, as noted below, for review within thirty (35) days after award of contract. All proposed deviations from Specifications must be clearly listed and submitted separately under a prominent heading entitled "Substitutions."

A Fire Alarm Systems
B Communication Systems
C Pull Boxes and Cabinets
D Conduit and Wire
E Service and distribution
F Transformers

2.4 OPERATING AND MAINTENANCE MANUALS

Submit Operating and Maintenance Manuals of equipment as specified under Division 1. Verify exact quantity with architect, or engineer if no architect is involved.

2.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A Equipment shall be shipped in its original packages, to prevent damaging or entrance of foreign matter. Handling and shipping shall be performed in accordance with manufacturer's recommendations. Provide protective covering during construction.

B Replace at no expense to Owner, equipment or material damaged during the storage or handling, as directed by the engineer.

C Equipment shall be tagged with a weatherproof tag identifying equipment by name and purchase order number. Packing and shipping lists shall be included.

PART 3 – EXECUTION

3.1 CLEARANCE

Minimum code required clearances for electrical equipment shall not be violated.

3.2 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

A Only quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.

B The Electrical Contractor shall provide a Superintendent in charge of this work at all times to direct the quality of the installation.

3.3 COORDINATION

A Coordinate work with other trades to avoid conflict and to provide correct rough in and connection for equipment furnished under other trades and requiring electrical connections. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

B Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation and agreed price shall be at Contractor's risk and expense.

C Provide temporary feeds and connections to areas and equipment as required to allow phased construction and operation.

3.4 CUTTING AND PATCHING

All cutting and patching required for work of this Division is included herein. Coordination with General Contractor and other trades is imperative. Contractor shall bear the responsibility for and bear the added expense of adjusting for improper holes, supports, etc.

END OF SECTION

REQUEST FOR SUBSTITUTION

To: _____

A. _____ submits for your consideration the following product instead of the specified item:

1. Project: _____
2. Section or Sheet: _____, Article or Paragraph: _____
3. Specified Item: _____
4. Proposed Substitution (Mfg., Type, Model, etc.): _____
   _____

B. Complete all of the following:

1. Does this substitution off the Owner a cost credit (including costs for changes by other trades)? _____ How much? _____
2. Does this substitution offer earlier delivery or less construction time? _____
   How much? _____ How so? _____
3. How does the substitution affect any dimensions, layout, or details of other trades as shown on the Drawings? _____
   _____
   _____
4. What are the specific differences between this substitution and the specified item?
   _____
   _____
   _____

C. Attach the following items.

1. Manufacturer's technical data _____
2. Laboratory test or performance results _____
3. Drawings and wiring diagrams of the proposed product _____
4. Drawings and description of changes required by other trades _____
5. Manufacturer's guarantee and maintenance instructions _____

D. The undersigned agrees to pay for all additional review, design, testing, changes in contract documents, and construction as a result of the acceptance of this substitution, at no cost to the Owner.

E. Submitted by (Firm) _____

Print name _____

Signature_____ Date _____

Accepted ☐ Rejected ☐ Revise and Resubmit ☐ See Attached ☐

END OF REQUEST FOR SUBSTITUTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

Materials, equipment fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction, for the following:

A Conduit and raceways
B Wire and cables
C Outlet boxes
D Junction boxes
E Pull boxes
F Grounding

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Division 1
  1 Section 013300: Submittal Procedures
  2 Section 014000: Regulatory Requirements
  3 Section 016000: Product Requirements
  4 Section 017700: Execution and Closeout Requirements
  5 All other included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

Published specification standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.

A American Society for Testing and Materials
  1 ASTM B3: Standard Specification for Soft or Annealed Copper Wire
  2 ASTM B33: Standard Specification for Tin-Coated or Annealed Copper Wire for Electrical Purposes
  3 ASTM B738: Standard Specification for Fine-Wire Bunch-Stranded and Rope-Lay Bunch-Stranded Copper Conductors for Use as Electrical Conductors
  4 ASTM B355: Standard Specification for Nickel-Coated, Soft or Annealed Copper Wire
  5 ASTM D412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
B California Electrical Code (CEC)
C Institute of Electrical and Electronic Engineers (IEEE)
  1 IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
  2 IEEE 82: Standard Test Procedure for Impulse Voltage Tests on Insulated Conductors
  3 IEEE 95: Standard Test Procedure for Impulse Voltage Tests on Insulated Conductors
  4 IEEE 141: Recommended Practice for Electric Power Distribution for Industrial Plants
  5 IEEE 142: IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
  6 IEEE 241: Recommended Practice for Electric Power Systems in Commercial Buildings
  7 IEEE 242: Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)

8 IEEE 399: Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book)
9 IEEE 442: Guide for Soil Thermal Resistivity Measurements
10 IEEE 576: Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications
11 IEEE 1185: Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities

D Underwriters' Laboratories
1 UL 1: Flexible Metal Conduits
2 UL 5: Surface Metal Raceways and Fittings
3 UL 5B: Standard for Strut-Type Channel Raceways and Fittings
4 UL 5C: Standard for Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits
5 UL 6: Electrical Rigid Metal Conduit – Steel
6 UL 13: Power Limited Circuit Cables
7 UL 83: Thermoplastic Insulated Wires and Cables
8 UL 310: Electrical Quick-connect Terminals
9 UL 360: Liquid Tight Flexible Steel Conduit
10 UL 444: Communications Cables
11 UL 467: Grounding and Bonding Equipment
12 UL 486A: Wire Connectors
13 UL 486B: Wire Connectors
14 UL 486C: Splicing Wire Connectors
15 UL 486D: Sealed Wire Connector Systems
16 UL 486E: Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
17 UL 493: Thermoplastic Insulated Underground Feeder and Branch Circuit Cables
18 UL 510: Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
19 UL 514A: Metallic Outlet Boxes
20 UL 514B: Conduit, Tubing, and Cable Fittings
21 UL 514C: Nonmetallic Outlet Boxes, Flush-device Boxes, and Covers
22 UL 514D: Cover Plates for Flush-mounted Wiring Devices
23 UL 635: Insulating Bushings
24 UL 651: Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
25 UL 797: Electrical Metallic Tubing – Steel
26 UL 870: Wireways, Auxiliary Gutters, and Associated Fittings
27 UL 969: Marking and Labeling Systems
28 UL 1242: Standard for Electrical Intermediate Metal Conduit - Steel
29 UL 1332: Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment
30 UL 1446: Systems of Insulating Materials – General
31 UL 1479: Fire Tests of Through Penetration Firestops
32 UL 1565: Position Devices (includes cable ties and clamps)
33 UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords
34 UL 1652: Flexible Metallic Tubing
35 UL 1685: Vertical-tray Fire Propagation and Smoke Release Test for Electrical and Optical Fiber Cables
36 UL 1773: Standard for Termination Boxes
37 UL 1977: Component Connectors for Use in Data, Signal, Control, and Power Applications
38 UL 2024: Standard for Signaling, Optical Fiber and Communications Raceways and Cable Routing Assemblies
39 UL 2196: Test for Fire Resistive Cables
40 UL 2238: Standard for Cable Assemblies and Fittings for Industrial Control and Signal Distribution

41 UL 2239: Hardware for the Support of Conduit, Tubing, and Cable
42 UL 2256: Nonmetallic Sheathed Cable Interconnects
43 UL 2277: Flexible Motor Supply Cable and Wind Turbine Tray Cable
44 UL 2459: Insulated Multi-pole Splicing Wire Connectors
45 UL 2556: Wire and Cable Test Methods

1.4 QUALITY ASSURANCE

A Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
B Supply equipment and accessories new, free from defects.
C Equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state and local codes.
D Items of a given type shall be the products of the same manufacturer.
E Deliver, store and protect products under provisions of Section 016000.
F Ship equipment in its original packages, to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
G Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.
H Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

1.5 SUBMITTALS

A Submit under provisions of Section 013000 or 013300.
B Submittals shall include the following:
1 Table of contents
2 A complete set of detailed manufacturer’s specifications describing and illustrating all standard and special components and materials
3 Part numbers
4 Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5 Maintenance instructions and intervals
6 Calibration procedures and intervals
7 A complete set of drawings for any special items
8 Wiring diagrams
C Electronic submittals shall be searchable
D Seismic Restraint and Anchorage: Provide complete seismic anchorage and bracing for the lateral and vertical support of conduit and electrical equipment in accordance with CBC, Title 24, Part 2, Section 1616A.1 and ASCE 7-10 Section 13.6, and all provisions of this Section.
1 Submit calculations prepared and signed by a Structural Engineer licensed in the State of California, showing compliance with the above for all electrical equipment weighing more than 50 pounds, excepting items corresponding exactly in configuration and weight to those specified and detailed. Where anchorage details are not shown on drawings, the field installation shall be subject to the approval of the Electrical Engineer.
2 All equipment mounted on concrete shall be secured with post-installed concrete requiring a drilled hole. Power driven anchors are not acceptable. Minimum spacing shall be 10 diameter center-to-center and 5 diameters center to edge of concrete. Maximum allowable loads for tension and shear shall be as determined in compliance with ACI 318-14 Chapter 17 and the anchor’s ICC or IAPMO evaluation report. Acceptable manufacturers are Hilti, Red Head, and Simpson Strong Tie.

3 Conduit and suspended equipment shall be provided with supports and seismic restraints in accordance with Unistrut, Inc. Seismic Bracing Guide, or Super Strut Inc., Seismic Restraint System guide. Support requirements shall e based upon similar equipment; i.e., water piping as equivalent to conduit with wire fill. A copy of the guide shall be on the job site during construction.

E The submittal shall be substantially complete for all items and equipment furnished under this section.

F Individual drawings and data sheets submitted at random intervals will not be accepted for review.

G Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.

B The manuals shall, at minimum, include the following:
1 Table of contents
2 Manufacturer (including contact information)
3 Model number
4 Voltage ratings
5 Current ratings
6 List of capabilities
7 Environmental ratings
8 NEMA enclosure type
9 Maintenance instructions and intervals
10 Calibration procedures and intervals
11 Installation instructions
12 Repair instructions (where applicable)
13 As-built drawings

C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

PART 2 – PRODUCTS

2.1 CONDUIT AND OTHER RACEWAYS

A Rigid Conduit, also referred to as Galvanized Rigid Steel Conduit (GRS)
1 Material: High strength steel
2 Coating
a All uses: hot-dipped galvanized
b Underground or corrosive areas
1 40-mil, UV stabilized PVC coated
2 Coating shall conform to NEMA RN-1
3 Fittings shall be threaded.
4 Conduit shall be UL-6 listed.

B Intermediate Metal Conduit (IMC)
1 Material: Steel
2 Coating
a All uses: hot-dipped galvanized
b Underground or corrosive areas
1 40-mil, UV stabilized PVC coated
2 Coating shall conform to NEMA RN-1
3 Conduit shall be UL-1242 listed.

C Electrical Metallic Tubing (EMT)
1 Material: Steel
2 Coating
a All uses: hot-dipped galvanized
b Underground or corrosive areas
1 40-mil, UV stabilized PVC coated
2 Coating shall conform to NEMA RN-1
3 Fittings shall be threaded.
4 Connectors and couplings
a Water tight, steel compression type exterior and in wet locations. Use ETP Fittings InspectoRidge or approved equal when possible.
b Steel set screw type in interior, dry locations.

D Non-metallic conduit
1 Conduit shall be schedule 40 PVC (minimum)
2 Approved for use as non-metallic raceway with 90°C conductors
3 Comply with NEMA TC-2 and NEMA TC-3

E Flexible Metallic Conduit
1 Material: High strength, hot-dipped galvanized steel
2 Construction: Interlocked
3 Conduits in damp, wet, or corrosive areas shall be liquid tight type with PVC jacket extruded over the steel conduit.

F Fittings and accessories
1 Fittings and accessories for all conduit types shall be approved for the purpose and equal in all respects to the conduit or raceway.
2 Fittings and accessories for metallic conduits shall be made of ferrous metal and galvanized after fabrication.

G Pull lines
1 Pull line shall be 1/8 inch diameter, yellow color.
2 Pull lines shall be Tubbs Cordage "Polyline" or approved equal.

H Wireways
1 NEMA type
a NEMA-1 for dry locations
b NEMA-3R or NEMA-4 for damp and wet locations
c NEMA-4X for corrosive locations
2 Metal type
a Non-corrosive locations: mild steel
b Corrosive locations: stainless steel
3 Thicknesses
a 6”x6” cross-section and smaller: 16 gauge
b 8”x8” cross-section and larger: 14 gauge
4 Finish: The entire enclosure shall be finished as follows:
a Degreasing
b Cleaning
c Phosphatizing
d Electrostatic deposition of polymer polyester powder coating followed by baking to produce a hard, durable finish.
1 The average thickness of the paint film shall be 2.0 mils.
2 Paint film shall be uniform in color and free from blisters, sags, flaking and peeling
e Finish shall conform to UL 50 and UL 50E.
f Color shall match surrounding area.
5 Covers
a Wireways shall have hinged covers.
b NEMA 3R, 4 and 4X wireways shall be a gasket on the inside of the cover to seal the wireway when cover is closed.

c Covers shall have latches to secure the cover in the closed position.

6 Wireways shall be UL listed.

I Raceways shall be UL listed.

2.2 WIRE AND CABLE

A Conductors for power and lighting systems 600V or less:

1 Conductors shall be 90°C rated.

2 Conductors size #12 AWG and larger shall be stranded copper.

3 Type:

a THWN for wet or underground locations

b THHN for dry locations.

c 90°C rated

4 Minimum conductor size for voltage drop:

a Minimum size #12 AWG for runs 50 feet or less for 208/120V systems or 100 feet or less for 480/277V systems

b Increase conductor by one size by one method below:

1 For each additional 50 feet for 208/120V systems or 100 feet for 480/277V systems.

2 Calculate voltage drop and size as directed by CEC Voltage Drop Restrictions.

c Underground circuits shall be #8 AWG minimum wire, unless otherwise noted.

d Once the contractor has determined conductors' route, calculate the minimum size to meet maximum voltage drop allowed per CEC using $D_{min}=C*L*I/(V_D*N)$.

1 D_{min} is the minimum diameter (circular mills)

2 C=24 for copper, C=39 for aluminum

3 L is conductor length (feet)

4 I is the current (amps)

5 V_D is the maximum allowable voltage drop (volts)

6 N is the quantity of parallel conductors per phase

5 Minimum size conductors for OCPD shall be determined from CEC Table 310.16 with ampacity corrected for 115°F.

6 Conductor size shall the largest size to meet maximum voltage drop (2.2 A 4) and to meet CEC ampacity requirements (2.2 A 5).

B For Signal and Communication Circuits:

1 Special Cables: As specified on Drawings.

2 Conductors for general communications use: Stranded copper conductor, #16 AWG minimum, with THWN insulation for underground or wet locations and THHN insulation for dry locations.

3 Ends of stranded conductors shall be tinned.

2.3 OUTLET BOXES, JUNCTION BOXES, AND PULL BOXES

A Above ground locations

1 Outlet Boxes

a Hot-dipped galvanized after fabrication

b Of required size, minimum 4 inches square, for flush mounted devices and lighting fixtures

c Cast type with gasketed covers for outdoor or wet locations.

d Device and fixture back boxes shall be 2-1/4" deep, minimum.

2 Junction and Pull Boxes

a Use outlet boxes with appropriate covers as junction boxes wherever possible.

b Larger junction and pull boxes
1 Sheet steel, hot dipped galvanized after fabrication, finished gray baked enamel
2 Sized according to code
3 Screw-on covers.

B In-ground pull boxes, handholes, and manholes
1 Precast concrete type with required extension collars.
2 Covers
a Lids shall be steel or reinforced concrete, as shown on plans. Pull box lids in traffic areas or large grassy areas subject to mowing by riding mowers shall traffic rated.
b Covers shall include hold down bolts.
c Top of cover shall be flush with top of box.
d Covers shall be identified as ELECTRICAL, SIGNAL, or COMMUNICATIONS unless otherwise specified.
3 Size boxes as indicated on Drawings. If size is not indicated on Drawings, use CEC as a minimum requirement.
4 Boxes shall have 2” thick (minimum), reinforced concrete bottoms with 1” diameter drain hole over 12” of crushed rock.
5 Boxes shall have approved cable supports.
6 Concrete encased stubs for handholes extending five (5) feet beyond handhole.
7 All pull boxes shall be no smaller than a Christy N-9.
8 All pull boxes shall be set flush to finished grade and shall have an 8-inch wide by 3-inch thick concrete mow strip poured around it.
9 Manufacturer shall be Brooks Products, Oldcastle Enclosure Solutions (Christy), Jensen Precast, or approved equal.
10 All sections between box, extension rings, etc. and penetrations shall be sealed with mortar.

C Floor Boxes
1 Provide Walker or equal Modulink non-metallic floor box for concrete areas.
2 Provide quantity of boxes required to accommodate each device.
3 Provide Walker Wood Floor Boxes at wood floors provide quantity required to accommodate each device.
4 Provide brass flip cover lids.

D Outlet boxes, junction boxes, pull boxes, etc. recessed in a concrete wall shall be deep masonry boxes.

2.4 CONDUIT AND EQUIPMENT SUPPORTS

A Conduit supports
1 For Individual conduit runs not directly fastened to the structure: Rod hangers
2 For multiple conduit runs: Trapeze type conduit support designed for maximum loading deflection not exceeding manufacturer's recommendations.

B Materials
1 All materials not otherwise noted:
a Steel with the finished part hot dipped galvanized
b Stainless steel for corrosive or damp environments
2 All bolts and nuts shall be stainless steel.

C Supports anchored to earth shall be anchored in a concrete base per details.

D Manufacturers shall be Caddy, Unistrut, Powerstrut, or approved equal.

E All exposed channels shall have end caps made by the channel manufacturer and designed for use with the channel.

2.5 WIRE CONNECTORS

A For wire size #8 AWG and smaller: Insulated, screw type, rated 105°C, 600V for building wiring and 1000V for fixtures; Scotchlok, Ideal, or approved equal.
B For wire size #6 AWG and larger: T&B or approved equal screw type with 3M "#33+" or Plymouth "Slipknot Gray" tape insulation.
C Underground wire splices
1 Connect ends of conductors with copper compression connectors, 3M Scotchlok or approved equal.
2 Seal splice with inline resin splice kit approved for weather exposure, direct burial, and wet locations, 3M Scotchcast or approved equal.
D Only set screw, compression type connectors may be used for MC cables. Fish hook/open tang connectors are prohibited.

2.6 GROUNDING

A Ground Rods
1 3/4 inch diameter
2 Copper weld type
3 10 feet in length.
B Ground Wire: Conductors shall be medium-hard drawn, copper, and stranded, with sizes as shown on drawings.
C Utilize CADWELD Multi-System Exothermic Welding for below grade ground connections.
D Bolts, nuts, and washers shall be bronze, cadmium plated steel, or other corrosion resistant material approved for the purpose.

2.7 MISCELLANEOUS MATERIALS

A All screws, bolts, nuts, and washers on equipment outdoors or in wet or corrosive environments shall be stainless steel.

2.8 SEALANTS

A General purpose sealant: One-part polysulfide or polyurethane, Federal Standard TT-S-00230c or two-part polyurethane, Federal Standard TT-SS-227E of Mameco Vulkem 116 or 227 or approved equal product manufactured by Products Research and Chemical Corporation. Pecora, Sika, Sonneborn, or Tremco may be substituted under provisions of Section 016000.
B Conduit sealant
1 Two-part, self-curing urethane
2 Non-sagging
3 Liquid and gas tight
4 Chemically stable once cured
5 Compatible with conduit and conductor materials
6 Designed for use as conduit seal
C Fire retardant sealant: Dow Corning Company, Type 3-6548 silicone RTV foam sealant, closed cell, 18 lb. density, 2-part system with UL certification. Type 96-081 one-part sealant shall be used for small spaces and cracks. 3M Fire Barrier Caulk CP25 is also acceptable.

2.9 IDENTIFICATION

A Nameplates:
1 White, acrylic plastic suitable for indoor or outdoor use
2 Face colored as below with engraved, white, 3/16” minimum, Arial or similar font characters

a Equipment on normal systems: Black face
b Equipment on emergency systems: Red face

3 Clear plastic overlay suitable for indoor or outdoor use that can be replaced if vandalized.
4 Sign shall include device name, voltage, and size.
5 Outdoor nameplates shall be UV stable and fade resistant.

B Pull line identification tags:
1 Aluminum plate
2 1/8" tall (minimum), Arial (or similar) font, identifying text stamped on plate
3 Tags shall describe conduit's length, source, and destination.

PART 3 – EXECUTION

3.1 GENERAL

A Electric system layouts indicated on the Drawings are generally diagrammatic but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of cable and wiring and the locations of outlets by the structure and equipment served. Dimensions shall be taken from Architectural Drawings.
B Consult all other Drawings. Verify scales and report any dimensional discrepancies or other conflicts to architect, or engineer if no architect is involved, before submitting bid.
C Home runs to panelboards are indicated as starting from the outlet nearest the panel and continuing in the general direction of that panel. Continue such circuits to the panel as though the routes were completely indicated. Terminate homeruns of signal, alarm, and communications system in a similar manner.
D Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of Architect and conform to structural requirements when cutting or boring the structure is necessary or permitted.
E Furnish and install necessary hardware, hangers, blocking, brackets, bracing, runners, required for equipment specified under this section.
F Provide necessary backing required to insure rigid mounting of outlet boxes.
G Install pull line in all conduits to remain that will have their conductors removed.

3.2 INSTALLATION OF CONDUIT

A Run conduit concealed unless otherwise noted or shown on Drawings.
B Run exposed conduit parallel to or at right angles to center lines of columns and beams.
C Run no conduit in concrete slabs or floors except at point of penetration. Penetrations shall be at right angles to slab surfaces.
D Install conduit above ceilings to avoid obstructing removal of ceiling tiles, lighting fixtures, air diffusers, etc.
E Conduit shall not cross any duct shaft or area designated as future duct shaft. Coordinated with mechanical work to avoid any conflict.
F Install pull line in empty conduit installed under this contract. Provide and install labels as describe in "Identification" sub-section.
G Spare conduits shall be capped to prevent intrusion of moisture and foreign objects.
H Minimum conduit size shall be 1/2 inches when installed above ground and 3/4 inches when installed underground or under building slabs. Increase conduit size as required for wiring. Size for conduit, unless specifically shown otherwise, shall be determined from Table 3 for all conductors, Chapter 9 of latest National Electric Code.
I Conduit shall be galvanized rigid conduit:
J Use flexible steel conduit in the following applications:
1 Recessed lighting fixtures.
2 Motor connections.

3 Connection between fan plenum and structure.
4 At expansion joints.
5 At transformers and other equipment which produce vibration.

K Provide junction boxes/pull boxes as required to limit any power system conduit run to a maximum of four (4) 90 degree bends (two (2) 90 degree bends for signal communication system conduit runs) or to avoid "U" bends.

L Conduit Supports:
1 Support conduit with Underwriters' Laboratories listed conduit support intervals required by the California Electric Code.
2 Wire or sheet metal strips are not acceptable for conduit not directly fastened to structure or for multiple conduit runs.
3 Individual conduit 1/2 inch and 3/4 inch size may be supported from ceiling support wire with Caddy clips only if acceptable to local code. Only one conduit is permitted to be attached to any ceiling support wire. Hang such conduit so as not to affect level of ceiling.
4 Avoid attaching conduit to fan plenums. When it is necessary to support conduit from fan plenum, provide a length of flexible conduit between the section attached to the fan plenum and other sections. Provide a length of flexible conduit between the portion attached to the building to minimize transmission of vibration to the building structure.

M Conduit penetration of roof, walls, floors and ceilings shall be sealed to preserve the integrity of waterproofing, fire rating and soundproofing for which the roof, wall, floor or ceiling is designed. Materials and methods used shall conform to that specified under Architectural sections.

N Where flush branch circuit panelboards or terminal cabinets are shown on walls, stub a minimum of four (4) 1 inch empty conduit into overhead ceiling spaces and four (4) 1 inch empty conduit into space below floor (if any) in addition to conduit required for circuit wiring.

O Paint all exposed conduit to match its surroundings.

P Where rigid steel conduit runs in direct contact with the earth, conduit shall be wrapped with 10-mill PVC tape to form 40 mil of protection or shall have factory applied PVC coating.

Q Label all conduits at each terminus, pull box, and junction box.

R All conduits shall have a minimum of one pull line.

S All pull lines shall be tagged at both ends so as to indicate the length of the conduit run, source, and the destination.

3.3 INSTALLATION OF WIRE

A Install all wiring in raceway unless specifically shown or noted otherwise.

B Pull no wire into any portion of the conduit system until construction work which may damage the wire has been completed.

C Install wire continuous from outlet to outlet or terminal to terminal. Splices in cables when required shall be made in handholes, pull boxes or junction boxes. Make branch circuit splices in outlet boxes with 8 inches of correctly color-coded tails left in the box.

D Make splices in wires and cables utilizing specified materials and methods.

E Cables and wires passing through handholes shall be full looped inside the handhole (360 degree) and supported on galvanized steel racks, beginning 10” above the bottom of the handhole. Leave handhole in clean condition with debris removed.

F Make ground, neutral, and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to ground terminal of devices when the device is not approved for grounding through the mounting screws.

G Provide Brady wire markers where number of conductors in a box exceed four (4).

H Wiring shall be tested for continuity (600V and below). All systems shall be entirely free from grounds, short circuits, and any or all defects.

I Measure and record the insulation resistance of 600 volt insulated conductors size #4/0 AWG and larger using a 500 volt megger for one minute. Make tests with circuits isolated from source and load.

J All conductor bends must have a radius greater than or equal to the manufacturer's listed bending radius.

K Label all conductors at each terminus, pull box, and junction box.

3.4 WIRE COLOR CODE

A Color code conductors. Wire sized #8 AWG and smaller shall have integral color-coded insulation. Wire sizes #6 AWG and larger may have black insulation but shall be identified by color coded electrical tape at junction, splice, pull and termination points. Apply color tape with 1/2 lap to at least 6 inches of the conductor.

B Color code wire as follows:

Conductors	208/120V	480/277V
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	White or Gray (consistent throughout facility)
Ground	Green	Green

3.5 CONNECTIONS TO EQUIPMENT

A General:

1 Furnish and install required power supply conduit and wiring to equipment. See below for other wiring required.

2 Furnish and install a disconnect switch immediately ahead of and adjacent to each magnetic motor starter or appliance unless the motor or appliance is located adjacent to and within sight of the serving panelboard, circuit breaker or switch. Verify equipment nameplate current ratings prior to installation.

3 Mount motor starters including those furnished under other sections or specifications and provide power wiring to them.

4 Install rough-in work for equipment from approved shop drawings to suit the specific requirements of the equipment.

5 Furnish and install magnetic motor starters that are shown on the Drawings or specified under other divisions to be furnished under this division of work. Verify equipment nameplate ratings prior to installation and furnish adequately rated starters for the loads.

6 Furnish and install manual thermal protection for motors not integrally equipped with thermal protection.

7 Furnish and install 120V power to each control panel and time switch requiring a source of power to operate.

B Heating, ventilating, and air conditioning equipment:

1 Coordinate with mechanical contractor for sizes, locations and details of motors, heating units, and control requirements.

2 Provide required power supply conduit and wiring to equipment.

3 Provide a suitable means of disconnect switch immediately ahead of and adjacent to each motor and appliance unless the motor or appliance is located adjacent and within sight of the service panelboard, circuit breaker or switch at a distance allowed by codes. Verify equipment nameplate current ratings prior to installation. Provide a disconnect means at each magnetic motor starter.

4 Provide magnetic motor starters required under this division of work.

5 Provide manual thermal protection for motors not integrally equipped with thermal protection.
6 Line and low voltage temperature control and interlock wiring, conduit, and required connections are a part of other divisions unless specifically shown or noted on the Drawings as to be furnished under this section.
7 Provide 120V power supply to control panels, time switch furnished and installed under other divisions of work.
8 Furnish and install 120V power to each duct detector scheduled for operation of fire dampers or shut down of mechanical equipment. Coordinate the exact quantity and locations with the mechanical drawings.

C Plumbing and other contractor-furnished and Owner-furnished equipment:
1 Required power and control conduit, wiring and connections are included under this section of the work. Control sensing and alarm devices will be furnished under the respective section of the contract supplying the equipment unless noted otherwise. These devices will be located in pipes, ducts, vessels, tanks, etc., and will be mounted in a place by the Contractor furnishing the devices. Other devices shall be mounted under this section of the work.
2 Control panels for packaged equipment will be furnished under the respective section of the contract supplying the equipment unless otherwise noted. Installation and connection of the control panels are under this section of the work.

3.6 SYSTEM NEUTRAL GROUND

A Ground the neutral conductor of each transformer to limit the maximum potential above ground due to normal operating voltage and limit the voltage level due to abnormal conditions.
B Ground transformers with secondary voltage 600V class or less as follows: 3 phase, 4 wire wye connected: ground neutral point.
C For transformers 75kVA size or lower with primary voltage 480V or lower, the primary equipment ground conductor may be used for grounding the secondary neutral provided it is adequately sized in accordance with CEC system ground conductor size.

3.7 EQUIPMENT GROUND

A Ground non-current carrying metal parts of electrical equipment enclosures, frames, or conductor raceways to provide a low impedance path for line to ground fault current and to bond all non-current carrying metal parts together. Install a ground conductor in each raceway system. Equipment ground conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded. Size ground conductors per CEC 250.95 unless otherwise shown on drawings.
B Grounding conductors shall be identified with green insulation. Where green insulation is not available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or enclosure device.
C Install metal raceway couplings, fittings and terminations secure and tight to insure good ground continuity. Provide grounding bushing and bonding jumper where metal raceway is not directly attached to equipment metal enclosure and at concentric knockouts.
D Lighting fixtures shall be securely connected to equipment ground conductors. Outdoor lighting standards shall have a factory installed ground for terminating the ground wire.
E Motors shall be connected to equipment ground conductors with a conduit grounding bushing and with a bolted solderless lug connection on the metal frame.

3.8 STRUCTURAL GROUND

A Concrete encased electrode shall be 2 inches above the bottom of concrete footing where shown on drawings. See drawings for details.

B Domestic, chilled and hot water mains and fire protection metallic water pipes shall be connected to the ground bus with #4/0 AWG bare copper conductor at a minimum of two points.

C Miscellaneous metal objects including piping, vessels and structural shapes within six feet of metallic objects connected to the ground system and which are not interconnected mechanically with the grounding system, shall be interconnected with a minimum #6 AWG bare copper conductor.

3.9 IDENTIFICATION

A Provide and install nameplates on all switchboards, distribution boards, panels, motor starters, VFDs, transformers, safety switches/disconnects, push buttons, selector switches, pilot lights, and other similar devices. Fasten nameplates to equipment with one sheet metal screw at each corner.

B Provide and install labels on lighting switches and convenience and special purpose receptacles to show panel and circuit number to which the device is connected.

C Provide and install identification tags on all conduit pull.

D Provide label meeting ANSI Z535 standards on motors reading:

WARNING

AUTOMATIC EQUIPMENT
MAY START AT ANY TIME

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

Materials, equipment fabrication, installation and tests in conformity with equipment applicable to this project, applicable codes and authorities having jurisdiction, for grounding

1.2 RELATED SECTIONS

A All included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS

Published specifications standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 16000.

1.4 QUALITY ASSURANCE

A Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
B Supply equipment and accessories new, free from defects.
C Supply equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state and local codes.
D Items of a given type shall be the products of the same manufacturer.

1.5 SUBMITTALS

A Submit under provisions of Section 01330. Provide detailed description of items supplied, including specifications, performance characteristics, materials, wiring diagrams and schedules.
    1 Submit evidence that products satisfy seismic requirements for the State of California.
    2 Submit evidence of compliance with the applicable standards listed under Article 1.3 of this section.
B Manufacturer's Instructions: Submit manufacturer's installation instructions.
C Product Data: Submit manufacturer's descriptive literature.
D Shop Drawings: Submit complete fabrication details, elevations and sections of switchboard, dimensions, space available for conduit, rating, short circuit withstand ability of bus and lowest rated device, circuit schedule showing circuit number, device description, device frame ampere rating and trip, fuse clip ampere rating, termination lug size, feeder and circuit identification, conductor ratings and one-line and wiring diagrams. Include both elementary diagram and terminal to terminal wiring diagrams.
E Substitutions: Items of same function and performance shall be in conformance with Division 1.
F Submit field test and operations check report for circuit breakers and motor starters under provisions of Section 16080.

1.6 OPERATION AND MAINTENANCE DATA

A Submit operation instructions, maintenance and repair data under provisions of Division 1.

B Ship equipment in its original packages to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.

C Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.

D Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

PART 2 – PRODUCTS

2.1 GROUND RODS

Ground rods shall be:

A. 3/4 inch diameter
B. Copper weld type
C. 10 feet in length.
D. Ground rings

2.2 BARE COPPER GROUND WIRE

Conductors shall be medium-hard drawn, copper, and stranded, with sizes as shown on drawings.

2.3 BELOW GRADE GROUND CONNECTIONS

Utilize CADWELD Multi-System Exothermic Welding.

2.4 HARDWARE

Bolts, nuts and washers shall be bronze, cadmium plated steel, or other non-corrosive material, approved for the purpose.

PART 3 – EXECUTION

3.1 SYSTEM NEUTRAL GROUND

A Ground the neutral conductor of each transformer to limit the maximum potential above ground due to normal operating voltage and limit the voltage level due to abnormal conditions.

B Ground transformers with secondary voltage 600V class or less as follows: 3-phase, 4-wire wye connected: ground neutral point.

C For transformers 75kVA size or lower with primary voltage 480V or lower, the primary equipment ground conductor may be used for grounding the secondary neutral provided it is adequately sized in accordance with CEC system ground conductor size.

3.2 EQUIPMENT GROUND

A Ground non-current carrying metal parts of electrical equipment enclosures, frames, or conductor raceways, structural metal supports for the mechanical and plumbing equipment to provide a low impedance path for line-to-ground fault current and to bond all non-current carrying metal parts together. Install a ground conductor in each raceway system. Equipment ground conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded. Size ground conductors per CEC 250-95 unless otherwise shown on drawings.

B Grounding conductors shall be identified with green insulation. Where green insulation is not available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or enclosure device.

C Install metal raceway couplings, fittings and terminations secure and tight to insure good ground continuity. Provide grounding bushing and bonding jumper where metal raceway is not directly attached to equipment metal enclosure and at concentric knockouts.

D Lighting fixtures shall be securely connected to equipment ground conductors. Outdoor lighting standards shall have a factory installed ground for terminating the ground wire.

E Motors shall be connected to equipment ground conductors with a conduit grounding bushing and with a bolted solderless lug connection on the metal frame.

3.3 STRUCTURAL GROUND

A Concrete encased electrode shall be 2 inches above the bottom of concrete footing where shown on drawings. See drawings for details.

B Domestic, chilled and hot water mains and fire protection metallic water pipes shall be connected to the ground bus with #3/0 AWG bare copper conductor at a minimum of two points.

C Miscellaneous metal objects including piping, vessels and structural shapes within six feet of metallic objects connected to the ground system and which are not interconnected mechanically with the grounding system, shall be interconnected with a minimum #3/0 AWG bare copper conductor.

3.4 GROUND RESISTANCE TEST

A Building ground electrode resistance testing shall be accomplished with a ground resistance, direct reading, single test meter utilizing the Fall-of-Potential method and two (2) referenced electrodes. Perform test prior to interconnection to other grounding system. Orient the concrete encased ground electrode to be tested and the two referenced electrodes in straight line spaces fifty (50) feet apart. Drive the two (2) reference electrodes ten (10) feet deep.

B Test results shall be in writing, and shall show temperature, humidity and condition of the soil at the time of the tests. In the case where the ground resistance exceeds 25 ohms, add an additional ground rod and retest. Add additional ground rods when necessary in order to bring the ground resistance below 25 Ohms. All testing shall be done prior to concrete pour and in the presence of the inspector of record. Provide test results for engineer review.

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Hangers and supports for electrical equipment and systems.
B. Construction requirements for concrete bases.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Division 1
  1 Section 013300: Submittal Procedures
  2 Section 014000: Regulatory Requirements
  3 Section 016000: Product Requirements
  4 Section 017700: Execution and Closeout Procedures
  5 All other included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A Published specifications standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.
B American Society for Testing and Materials (ASTM)
  1 ASTM A36/A36M: Standard Specification for Carbon Structural Steel
  2 ASTM A167: Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  3 ASTM A276: Standard Specification for Stainless Steel Bars and Shapes
  4 ASTM A325: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength
  5 ASTM A563: Standard Specification for Carbon and Alloy Steel Nuts
  6 ASTM B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  7 ASTM B632: Standard Specification for Aluminum-Alloy Rolled Tread Plate
  8 ASTM B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
  9 ASTM E488: Standard Test Methods for Strength of Anchors in Concrete Elements
  10 ASTM F594: Standard Specification for Stainless Steel Nuts
C American Welding Society (AWS)
  1 AWS D1.1: Structural Welding Code - Steel
D California Building Safety Codes (CBSC)
  1 California Building Code (CBC)
  2 California Electrical Code (CEC)
E General Services Administration
  1 FF-S-325
  2 W-C-582: Conduit, Raceway, Metal and Fittings: Surface
  3 WW-H-171: Hanger and Support, Pipe
F ICC Evaluation Service (ICC-ES)
  1 ESR-1917
G Manufacturers Standardization Society (MSS)
  1 MSS SP-58: Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
  2 MSS SP-69: Pipe Hangers and Supports – Selection and Application
H Metal Framing Manufacturers' Association
  1 MFMA-4: Metal Framing Standard Publication

2 MFMA-101: Guidelines for the Use of Metal Framing
I National Electrical Contractors Association
1 NECA 1: Standard Practice of Good Workmanship in Electrical Construction
2 NECA 101: Standard for Installing Steel Conduits (Rigid, IMC, EMT)
J Underwriters' Laboratories
1 UL 2239: Hardware for the Support of Conduit, Tubing, and Cable

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with latest editions of the California Building Code and California Electric Code

1.5 SUBMITTALS

A. Submit under provisions of Section 013000 or 013300.
B. Submittals shall include the following:
1. Table of contents
2. A complete set of detailed manufacturer's specifications describing and illustrating all standard and special components and materials
3. Part numbers
4. Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5. Maintenance instructions and intervals
6. A complete set of drawings for any special items
C. Electronic submittals shall be searchable
D. Shop drawings shall be stamped and signed by a licensed structural engineer. Show fabrication and installation details and include calculations for the following:
1. Trapeze hangers: include product data for components
2. Steel slotted channel systems: include product data for components
3. Equipment supports
E. Welding certificates
F. The submittal shall be substantially complete for all items and equipment furnished under this section.
G. Individual drawings and data sheets submitted at random intervals will not be accepted for review.
H. Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit manuals at close out.
B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number
3 Load ratings
4 Material type(s)
5 Environmental ratings
6 Maintenance requirements
7 Installation instructions
8 Repair instructions (where applicable)
C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

1.7 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

PART 2 – PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems
   1. Comply with MFMA-4, factory-fabricated components for field assembly.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings:
      a. PVC, polyurethane, or polyester coating applied according to MFMA-4.
      b. Minimum thickness shall be 40 mils.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.
   6. Manufacturers:
      a. Cooper B-Line, Inc.
      b. ERICO International Corporation
      c. Hilti Corporation
      d. Thomas & Betts Corporation
      e. Unistrut
      f. Approved equal
B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
F. Mounting, Anchoring, and Attachment Components:
   1. General:
      a. Anchors shall be steel with corrosion resistant, durable coating or stainless steel
      b. Select anchors with strength required for anchor and as tested according to ASTM E488.
      c. Minimum length shall be eight times diameter.
      d. Tension, shear, and pullout capacities shall be appropriate for supported loads and building materials used
      e. Post installed anchors must be listed in a current evaluation report issued by one of the following:

1. International Code Council Evaluation Service (ICC-ES) (http://www.icc-es.org/reports/index.cfm?search=search)
2. City of Los Angeles Research Report

2. Powder-Actuated Fasteners:
   a. Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood
   b. Manufacturers:
      1. Hilti Corporation
      2. Simpson Strong-Tie Co., Inc.
      3. Approved equal
3. Mechanical-Expansion Anchors:
   a. Insert-wedge-type, stainless steel, for use in hardened portland cement
   b. Anchors shall meet the descriptive part of Federal Specifications FF-S-325 Group II, Type 2, Class 2, Style 1.
   c. Anchors shall be equivalent to Hilti Kwik-Bolt TZ.
4. Concrete inserts shall be steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58
5. Clamps for attachment to steel structural elements: MSS SP-58, type suitable for attached structural element
6. Through bolts shall be structural type, hex head, high strength and comply with ASTM A325
7. Toggle Bolts: All-steel springhead type
8. Hanger Rods: Threaded steel

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
B. Materials:
   1. Comply with requirements with ASTM A36 (ferrous metals), ASTM A167 and ASTM A276 (stainless steel), and ASTM B221 and B632 (aluminum) for shapes and plates.
   2. Hot dipped galvanized steel
   3. Stainless steel for corrosive areas

2.3 CONCRETE BASES

A. Concrete Pad
   1. Concrete shall have strength of 3000 PSI within 28 days.
   2. The pad shall be large enough to achieve the following:
      a. Edge of anchor bolt holes shall be a minimum of 10 times the bolt diameter from edge of pad.
      b. Edge of equipment shall be a minimum of 8 inches from edge.
   3. Minimum thickness shall be 12 inches with 3 inch deep by 12 inch wide footing around perimeter
   4. Bottom of footings shall be a minimum of 8” below finished grade.
   5. Pad shall include #4 rebar at 10 inch intervals in both x direction and y direction.
B. Concrete Pole Bases: Refer to Typical Details

PART 3 – EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by California Electrical Code. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
C. Multiple Raceways or Cables:
   1. Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   2. Secure raceways and cables to these supports with two-bolt conduit clamps
D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in California Electric Code.
C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (890 N).
D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code.
   1. Wood framing: Fasten with lag screws or through bolts.
   2. Light gauge steel framing: self tapping screws
   3. Steel beams: beam clamps
   4. Concrete: expansion fasteners

3.3 CONDUIT SUPPORTS

A Conduit supports
   1 For Individual conduit runs not directly fastened to the structure: Rod hangers
   2 For multiple conduit runs: Trapeze type conduit support designed for maximum loading deflection not exceeding manufacturer's recommendations.
   3 Wire or sheet metal strips are not acceptable for conduit not directly fastened to structure or for multiple conduit runs.
B Support conduit with Underwriters' Laboratories listed conduit support intervals required by the California Electric Code.
C Individual conduit 1/2 inch and 3/4 inch size may be supported from ceiling support wire with Caddy clips only if acceptable to local code. Only one conduit is permitted to be attached to any ceiling support wire. Hang such conduit so as not to affect level of ceiling.
D Avoid attaching conduit to fan plenums. When it is necessary to support conduit from fan plenum, provide a length of flexible conduit between the section attached to the fan plenum and other sections. Provide a length of flexible conduit between the portion attached to the building and the rest of the conduit run to minimize transmission of vibration to the building structure.
E Supports anchored to earth shall be anchored in a concrete base per details.

3.4 INSTALLATION OF POST-INSTALLED ANCHORS

A. Minimum distances
   1. Bolt hole edge to edge of concrete: 10 times bolt diameter
   2. Bolt center to bolt center: 12 times bolt diameter

B. Expansion type anchors
   1. Anchor shall be installed and torque per manufacturer's recommendations.
   2. Setting verification:
      a. Torque-controlled anchors: Following attainment of 10% of the required torque, torque-controlled anchors shall not require more than six (6) additional complete turns of the nut during installation to achieve the manufacturer's specified installation torque. The extent of bolt projection after installation shall be measured to confirm that this requirement has been met.
      b. Displacement-controlled anchors: The position of the plug in the anchor shell shall be checked with the manufacturer-supplied installation tool or other appropriate device. The position of the plug shall conform to the manufacturer's specifications.
   3. Allowable loads
      a. Anchors not installed in underside of beam/slab:
         1. When tested in accordance with AC01, Section 5.6: Values listed in ICC-ES report
         2. When not tested in accordance with AC01, Section 5.6: 80% of values listed in ICC-ES report
      b. Anchors installed in underside of beam/slab:
         1. When tested in accordance with AC01, Section 5.6: Values for anchor without special inspection or in cracked concrete in ICC-ES report
         2. When not tested in accordance with AC01, Section 5.6: 80% of values for anchor without special inspection or in cracked concrete in ICC-ES report

C. Epoxy-type (adhesive) Anchors
   1. Allowable loads: values from ICC-ES report when compliant with AC58.

D. Anchors must receive special inspection per CBC Section 1704.15.

3.5 TESTING AND INSPECTION OF POST-INSTALLED ANCHORS

A. General
   1. Post-installed anchors shall be tested in accordance with the provisions of 2001 California Building Code Section 1923A.3.5, by an authority having jurisdiction accepted testing facility, unless approval of an alternative individual is obtained in advance from the authority having jurisdiction.
   2. If any anchor fails testing, test all anchors of the same type, not previously tested until twenty (20) consecutive anchors pass, then resume the initial test frequency. If the anchors are used for the support and bracing of non-structural components (pipe, duct or conduit), the twenty (20) shall be only those anchors installed by the same trade.
   3. Test equipment (including torque wrenches) is to be calibrated by an approved testing laboratory in accordance with standard recognized procedures.
   4. Regardless of which test method is chosen, test values and all appropriate criteria shall be shown on the contract documents.
   5. Anchor diameter refers to the thread size for the wedge and sleeve categories, and to the anchor outside diameter for the sleeve category.
   6. Apply proof test loads to wedge and sleeve anchors without removing the nut if possible. If not, remove nut and install a threaded coupler to the same tightness as the original nut using a torque wrench to apply the test load.
   7. For sleeve/shell internally threaded categories, verify that the anchor is not prevented from withdrawing by a baseplate or other fixtures. If restraint is found, loosen and shim or remove fixture(s) prior to testing.
   8. Reaction loads from test fixtures may be applied close to the anchor being tested, provided the anchor is not restrained from withdrawing by the fixture(s).

9. Alternate torque test procedures and test values for shell type anchors may be submitted to the enforcement agency for review and approval on a case-by-case basis when test procedures are submitted and approved by the enforcement agency.
10. Required test loads may be determined by either of the following methods:
    a. Twice the allowable tension load from Part 3.4.
    b. Tension or torque test values from the table and procedures.

Test Values (Hardrock or Lightweight Concrete)							
Anchor	**Wedge**		**Sleeve**		**Shell**		**Screw**
Diameter (in)	Load (lbs)	Torque (ft. lbs)	Load (lbs)	Torque (ft. lbs)	Load (lbs)	Torque (ft. lbs)	Torque (ft. lbs)
1/4	800	10	400	4	1000	-	-
5/16	-	-	400	5	1400	-	-
3/8	1100	25	700	10	1800	-	10
1/2	2000	50	900	20	2700	-	10
5/8	2300	80	1100	45	3700	-	10
3/4	3700	150	1400	90	5400	-	20
1	5800	250	-	-	-	-	-

11. If the manufacturer's recommended installation torque is less than the test torque noted in the table, the manufacturer's recommended installation torque should be used in lieu of the tabulated values.

B. Expansion-type Anchors
1. The test load may be applied by any method that will effectively measure the tension in the anchor, such as direct pull with a hydraulic jack, calibrated spring loaded devices, or a calibrated torque wrench. Displacement-controlled anchors such as drop-ins shall not be tested using a torque wrench.
2. Anchors tested with a hydraulic jack should exhibit no discernable movement during the tension test, e.g., as evidenced by loosening of the washer under the nut.
3. Anchors tested with a calibrated torque wrench must attain the specified torque within 1/2 turn of the nut.
4. Exceptions: Undercut anchors that are so designed to allow visual confirmation of full set, need not be tension or torque tested. If the manufacturer's installation torque is less than the specified test torque, use the manufacturer's specified installation torque for testing the anchor.
5. Apply proof test loads to wedge and sleeve anchors without removing the nut if possible. If not, remove nut and install a threaded coupler to the same tightness as the original nut using a torque wrench to apply the test load.
6. For sleeve/shell internally threaded categories, verify that the anchor is not prevented from withdrawing by a baseplate or other fixtures. If restraint is found, loosen and shim or remove fixture(s) prior to testing.
7. Reaction loads from test fixtures may be applied close to the anchor being tested, provided the anchor is not restrained from withdrawing by the fixture(s).
8. Shell type anchors should be tested as follows:
    a. Visually inspect 25% for full expansion as evidenced by the location of the expansion plug in the anchor body. Plug location of a fully expanded anchor should be as recommended by the manufacturer, or, in the absence of such recommendation, as determined on the job site following the manufacturer's installation instructions. At least 5% of the anchors shall be proof loaded as indicated in the table above, but not less than three anchors per day for each different person or crew installing anchors, or;
    b. Test installed anchors per current edition of the CBC Section 1913A.7.

C. Epoxy-type (adhesive) Anchors

1. Epoxy-type (adhesive) anchors shall be tension tested per current edition of the CBC Section 1913A.7. The tension test load shall equal twice the allowable load for the specific location of the anchor to be tested (i.e., accounting for edge distance) or 80% of the yield strength of the bolt ($0.8A_bF_y$), whichever is less. The test procedures for expansion-type anchors in the attached table shall also be used for epoxy-type (adhesive) anchors. Torque testing of epoxy-type (adhesive) anchors is not permitted.
2. Where epoxy-type (adhesive) anchors are used as shear dowels across cold joints in slabs on grade and the slab is not part of the structural system, testing of those dowels is not required.
3. Anchors shall exhibit no discernible movement during the tension test.

D. Screw-type Anchors

E. The following criteria apply for the acceptance of installed anchors:
1. Hydraulic ram method: The anchor should have no observable movement at the applicable test load. For wedge and sleeve type anchors, a practical way to determine observable movement is that the washer under the nut becomes loose.
2. Torque wrench method: The applicable test torque must be reached within the following limits:
   a. Wedge or Sleeve type: One-half (1/2) turn of the nut.
   b. One-quarter (1/4) turn of the nut for the 3/8 in. sleeve anchor only.

3.6 PAINTING

A. Touchup:
1. Clean field welds and abraded areas of shop paint.
2. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting.
3. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
4. Comply with the following requirements
   a. Architectural painting specifications
   b. SSPC-PA 1 requirements for touching up field-painted surfaces.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

Anchoring and vibration isolation equipment for electrical equipment:

A. Isolation pads
B. Spring isolators
C. Restrained spring isolators
D. Channel support systems
E. Restraint cables
F. Hanger rod stiffeners
G. Anchorage bushings and washers

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Division 1
  1 Section 013300: Submittal Procedures
  2 Section 014100: Regulatory Requirements
  3 Section 016000: Product Requirements
  4 Section 017700: Execution and Closeout Procedures
  5 All other included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A Published specifications standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.
B American Society for Testing and Materials (ASTM)
  1 ASTM A36/A36M: Standard Specification for Carbon Structural Steel
  2 ASTM A325: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength
  3 ASTM A563: Standard Specification for Carbon and Alloy Steel Nuts
  4 ASTM B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
  5 ASTM E488: Standard Test Methods for Strength of Anchors in Concrete Elements
  6 ASTM F594: Standard Specification for Stainless Steel Nuts
C American Welding Society (AWS)
  1 AWS D1.1: Structural Welding Code - Steel
D California Building Safety Codes (CBSC)
  1 California Building Code (CBC)
  2 California Electrical Code (CEC)
E General Services Administration
  1 FF-S-325
  2 W-C-582: Conduit, Raceway, Metal and Fittings: Surface
  3 WW-H-171: Hanger and Support, Pipe
F ICC Evaluation Service (ICC-ES)
  1 ESR-1917
G National Electrical Contractors Association
  1 NECA 1: Standard Practice of Good Workmanship in Electrical Construction
H Underwriters' Laboratories

1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency meeting requirements of Part 1.6, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
D. Comply with latest editions of the California Building Code and California Electric Code

1.5 SUBMITTALS

A. Submit under provisions of Section 013000 or 013300.
B. Submittals shall include the following:
    1. Table of contents
    2. A complete set of detailed manufacturer's specifications describing and illustrating all standard and special components and materials
    3. Part numbers
    4. Evidence of compliance with the applicable standards listed under Article 1.3 of this section
    5. Maintenance instructions and intervals
    6. A complete set of drawings for any special items
    7. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
    8. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
        a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency meeting requirements of Part 1.6.
        b. Annotate to indicate application of each product submitted and compliance with requirements.
    9. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
C. Electronic submittals shall be searchable
D. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified licensed structural engineer responsible for their preparation.
    1. Design Calculations:
        a. Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
        b. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.
    2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
    3. Field-fabricated supports.
    4. Seismic-Restraint Details:
        a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Preapproval and Evaluation Documentation: By an agency meeting requirements of Part 1.6, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

E. Welding certificates.

F. Field quality-control test reports.

G. The submittal shall be substantially complete for all items and equipment furnished under this section.

H. Individual drawings and data sheets submitted at random intervals will not be accepted for review.

I. Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit manuals at close out.

B The manuals shall, at minimum, include the following:
- 1 Manufacturer (including contact information)
- 2 Model number
- 3 Load ratings
- 4 Material type(s)
- 5 Environmental ratings
- 6 Maintenance requirements
- 7 Installation instructions
- 8 Repair instructions (where applicable)

C Provide manuals in one of the following formats
- 1 Three hardcopies
- 2 PDF

1.7 PERFORMANCE REQUIREMENTS

Seismic-Restraint Loading:

A. Site Class as Defined in the CBC: Refer to structural plans

B. Assigned Seismic Use Group or Building Category as Defined in the CBC: Refer to structural plans
- 1. Component Importance Factor: Refer to structural plans
- 2. Component Response Modification Factor: Refer to structural plans
- 3. Component Amplification Factor: Refer to structural plans

C. Mapped Spectral Acceleration for Short Period (0.2 Second): Refer to structural plans

D. Site Coefficient for Short Period: Refer to structural plans

E. Maximum Spectral Response Acceleration for Short Period: Refer to structural plans

F. Design Spectral Response Acceleration for Short Period: Refer to structural plans

G. Mapped Spectral Acceleration for 1 Second Period: Refer to structural plans

H. Site Coefficient for 1 Second Period: Refer to structural plans

I. Maximum Spectral Response Acceleration for 1 Second Period: Refer to structural plans

J. Design Spectral Response Acceleration for 1 Second Period: Refer to structural plans

1.8 QUALIFICATIONS OF TESTING AGENCY

The testing agency shall meet the following requirements:

A. Federal OSHA criteria for accreditation of testing laboratories, Standard Number 1910.7 (Definition and Requirements for a nationally recognized testing laboratory). Membership in the National Electrical Testing Association constitutes proof of meeting such criteria.
B. Acceptable to authorities having jurisdiction.

PART 2 – PRODUCTS

2.1 VIBRATION ISOLATORS

A. Pads:
   1. Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   2. Resilient Material: Oil and water resistant, waffle embossed neoprene.
B. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency meeting requirements of Part 1.6.
B. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four (verify with structural engineer) times the maximum seismic forces to which they will be subjected.
C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.
F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
I. Mounting, Anchoring, and Attachment Components: Refer to Section 260529.
J. Steel parts shall be hot dipped galvanized after fabrication for dry areas or stainless steel for damp or wet locations.

PART 3 – EXECUTION

3.1 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency meeting requirements of Part 1.6.
B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:
   1. Install restrained isolators on electrical equipment.
   2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
   3. Install seismic-restraint devices using methods approved by an agency meeting requirements of Part 1.6 providing required submittals for component.
B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
D. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom

of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

Tests and Inspections:
A. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
B. Test at least 10% of each type and size of installed anchors and fasteners selected by Architect.
C. Test to 90 percent of rated proof load of device.
D. Measure isolator restraint clearance.
E. Measure isolator deflection.
F. Verify snubber minimum clearances.
G. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
H. Remove and replace malfunctioning units and retest as specified above.
I. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
C. Adjust active height of spring isolators.
D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 ELECTRICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Provide the owner with a schedule of all major supported or suspended electrical equipment. Include the following.
   1. Equipment Location
   2. Pads:
      a. Material
      b. Thickness
      c. Durometer
      d. Number of Pads
   3. Isolator Type
   4. Component Importance Factor
   5. Component Response Modification Factor
   6. Component Amplification Factor
B. Provide the owner with cut sheets for all other support equipment.

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

A Testing in conformity with equipment applicable to this project, applicable codes and authorities having jurisdiction
B Test equipment requirements listed in this section shall apply to testing required by all other sections in Division 26 specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Division 1
  1 Section 013300: Submittal Procedures
  2 Section 014100: Regulatory Requirements
  3 Section 016000: Product Requirements
  4 Section 017700: Execution and Closeout Procedures
  5 All other included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A Published specifications standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.
B California Electrical Code
C International Electrical Testing Association (NETA)
  1 NETA ATS: for Acceptance Testing Specifications for Electrical Power Equipment and Systems
D Institute of Electrical and Electronic Engineers
  1 IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
  2 IEEE 82: Standard Test Procedure for Impulse Voltage Tests on Insulated Conductors
  3 IEEE 95: Standard Test Procedure for Impulse Voltage Tests on Insulated Conductors
  4 IEEE 112: Standard Test Procedure for Polyphase Induction Motors and Generators
  5 IEEE 114: Standard Test Procedure for Single-Phase Induction Motors
  6 IEEE 115: IEEE Guide for Test Procedures for Synchronous Machines Part I—Acceptance and Performance Testing Part II—Test Procedures and Parameter Determination for Dynamic Analysis
  7 IEEE 141: Recommended Practice for Electric Power Distribution for Industrial Plants
  8 IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
  9 IEEE 241: Recommended Practice for Electric Power Systems in Commercial Buildings
  10 IEEE 242: Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)
  11 IEEE 252: Standard Test Procedure for Polyphase Induction Motors Having Liquid in the Magnetic Gap
  12 IEEE 259: Standard Test Procedure for Evaluation of Systems of Insulation for Dry-Type Specialty and General-Purpose Transformers
  13 IEEE 389: Recommended Practice for Testing Electronics Transformers and Inductors

14 IEEE 393: Test Procedures for Magnetic Cores
15 IEEE 399: Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book)
16 IEEE 400: Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above
17 IEEE 442: Guide for Soil Thermal Resistivity Measurements
18 IEEE 495: Guide for Testing Faulted Circuit Indicators
19 IEEE 576: Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications
20 IEEE 1188: Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
21 IEEE 1234: Guide for Fault Locating Techniques on Shielded Power Cable Systems
22 IEEE 1415: Guide for Induction Machinery Maintenance Testing and Failure Analysis
23 IEEE 1458: Recommended Practice for the Selection, Field Testing, and Life Expectancy of Molded Case Circuit Breakers for Industrial Applications

E National Institute of Standards and Technology (NIST)
F Underwriters' Laboratories
1 UL 1244: Electrical and Electronic Measuring and Testing Equipment
2 UL 1436: Outlet Circuit Testers and Similar Indicating Devices
3 UL 61010-2-030: Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 2-030: Particular requirements for testing and measuring circuits
4 UL 61010B-1: Electrical Measuring and Test Equipment – Part 1: General Requirements
5 UL 61010B-2-031: Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2: Particular Requirements for Hand-Held Probe Assemblies for Electrical Measurement and Test
6 UL 61010B-2-032: Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2: Particular Requirements for Hand-Held Current Clamps for Electrical Measurement and Test

1.4 QUALITY ASSURANCE

A The Contractor shall engage and pay for the services of a recognized independent testing laboratory for the purpose of performing inspections and tests as herein specified.
B The testing laboratory shall provide all material, equipment, labor and technical supervision to perform switch tests and inspections.
C It is the intent of these tests to assure that all electrical equipment, both Contractor and Owner supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.
D The tests and inspections shall determine the suitability for energizing.
E Schedule tests and give a minimum of two weeks advance notice to the Owner.

1.5 SUBMITTALS

A List of tests preformed
B Test procedures
C Test results
D The submittal shall be substantially complete for all items and equipment furnished under this section.
E Individual drawings and data sheets submitted at random intervals will not be accepted for review.

1.6 QUALIFICATIONS OF TESTING AGENCY

The testing agency shall meet federal OSHA criteria for accreditation of testing laboratories, Standard Number 1910.7 (Definition and Requirements for a nationally recognized testing laboratory). International Electrical Testing Association (NETA) accreditation constitutes proof of meeting such criteria.

1.7 TEST INSTRUMENT TRACEABILITY

A The testing laboratory shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.
B The accuracy shall be traceable to the National Institute of Standards and Technology (NIST) in an unbroken chain.
C Instruments shall be calibrated in accordance with the following frequency schedule:
  1 Field instruments: 6 months maximum.
  2 Laboratory instruments: 12 months.
  3 Leased specialty equipment: 12 months
D Dated calibration labels shall be visible on all test equipment.

1.8 FINAL SETTINGS

A The test report shall include the following: summary of project, description of equipment tested, description of test, list of test equipment used in calibration and calibration date, test results, conclusions and recommendations, and appendix, including appropriate test forms.
B The test report shall be bound and its contents certified.
C Submit three copies of the completed report to the architect, or engineer if no architect is involved, no later than fifteen (15) days after completion of test, unless otherwise directed.

1.9 FAILURE TO TEST

A Any system material or workmanship which is found defective on the basis of acceptance tests shall be reported directly to the architect or engineer if no architect is involved.
B Contractor shall replace the defective material or equipment and have test repeated until test proves satisfactory without additional cost to the Owner.

PART 2 – PRODUCTS: [NOT USED]

PART 3 – EXECUTION

3.1 GROUND RESISTANCE TEST

A Building ground electrode resistance testing shall be accomplished with a ground resistance, direct-reading, single test meter utilizing the Fall-of-Potential method and two (2) referenced electrodes. Perform test prior to interconnection to other grounding system. Orient the concrete-encased ground electrode to be tested and the two referenced electrodes in straight line spaces fifty (50) feet apart. Drive the two (2) reference electrodes ten (10) feet deep.
B Test results shall be in writing, and shall show temperature, humidity and condition of the soil at the time of the tests. In the case where the ground resistance exceeds 25 ohms, add an additional ground rod and retest. Add additional ground rods when necessary in order to bring the ground resistance below 25 Ohms. All testing shall be done prior to concrete pour and in the presence of the inspector of record. Provide test results for engineer review.

3.2 MISCELLANEOUS TESTING

A Functional and operational testing to the fire alarm, security system, telephone system, paging/intercom system, and all electrical components upon completion of electrical work.

B Perform an insulation resistance test on all switchboard busses, bus ducts; feeder conductors, including neutrals, using a megohmmeter. Minimum value for each conductor shall be 20 megohms.

3.3 ELECTRICAL DISTRIBUTION EQUIPMENT OPERATIONAL CHECK

A Electrical distribution equipment operational check includes main switchboards, distribution boards, panelboards, panels, switchgear, etc.

B Verify proper operating condition of all equipment mechanically and electrically including, but not limited to verifying operation of each circuit breaker trip device with a rating of 100A or more using an accurately metered timed instrument (by passing 300% rated current through each pole).

C If any equipment is found defective during operational check, it shall be replaced by the Contractor without cost to the Owner. The tests shall be repeated by the Contractor without cost to the owner until satisfactory results are obtained

3.4 CIRCUIT BREAKER ELECTRICAL COORDINATION STUDY

A Contractor shall provide a coordination study to determine trip settings of circuit breakers so the new breakers being installed are selectively coordinated between the up and down stream breakers.

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

This section includes minimum requirement for low voltage transformers.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Division 1
- 1 Section 013300: Submittal Procedures
- 2 Section 014100: Regulatory Requirements
- 3 Section 016000: Product Requirements
- 4 Section 017700: Execution and Closeout Procedures
- 5 All other included sections under Division 1

B All included sections under Division 26

C Plans

D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.

B Institute of Electrical and Electronics Engineers (IEEE)
- 1 IEEE 259: Standard Test Procedure for Evaluation of Systems of Insulation for Dry-Type Specialty and General-Purpose Transformers
- 2 IEEE 295: Electronics Power Transformers
- 3 IEEE 389: Recommended Practice for Testing Electronics Transformers and Inductors
- 4 IEEE 393: Test Procedures for Magnetic Cores
- 5 IEEE C57.12.01: Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings
- 6 IEEE C57.12.60: Standard Test Procedure for Thermal Evaluation of Insulation Systems for Dry-Type Power and Distribution Transformers, Including Open-Wound, Solid-Cast, and Resin-Encapsulated Transformers
- 7 IEEE C57.12.91: Standard Test Code for Dry-type Distribution and Power Transformers
- 8 IEEE C57.98: Guide for Transformer Impulse Tests

C National Electrical Manufacturers' Association
- 1 Transformers shall be manufactured and tested in accordance with NEMA ST20.
- 2 Transformers losses shall conform to NEMA TP1 requirements.
- 3 Transformer losses shall be tested in accord with NEMA TP2 procedures.
- 4 Transformers shall be labeled in accord with NEMA TP3 requirements.

D National Fire Protection Association
- 1 NFPA 70: National Electrical Code

E Underwriters' Laboratories
- 1 UL 50: Enclosures for Electrical Equipment, Non-environmental Considerations
- 2 UL 50E: Enclosures for Electrical Equipment, Environmental Considerations
- 3 UL 467: Grounding and Bonding Equipment
- 4 UL 486E: Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
- 5 UL 506: Specialty Transformers
- 6 UL 1332: Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment
- 7 UL 1446 Systems of Insulating Materials – General
- 8 UL 1561: Dry-type General Purpose and Power Transformers
- 9 UL 2763: Energy Efficient Harmonic Cancellation Transformers

10 UL 5085-1: Low Voltage Transformers – Part 1: General Requirements
11 UL 5085-2: Low Voltage Transformers – Part 2: General Purpose Transformers
12 UL 5085-3: Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers

1.4 QUALITY ASSURANCE

A Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
B Supply equipment and accessories new, free from defects.
C Supply equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state and local codes.
D Items of a given type shall be the products of the same manufacturer.
E Ship equipment in its original packages to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
F Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.
G Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

1.5 SUBMITTALS

A Submit under provisions of Section 013000 or 013300.
B Submittals shall include the following:
1 Table of contents
2 A complete set of detailed manufacturer’s specifications describing and illustrating all standard and special components and materials
3 Part numbers
4 Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5 Maintenance instructions and intervals
6 A complete set of drawings for any special items
7 Wiring diagrams
8 Drawings shall include designations, dimensions, operating controls, instruments, riser diagrams, routing diagrams etc.
C Electronic submittals shall be searchable
D Shop drawings required: drawings and descriptions containing information of weight, dimensions, rated kVA, sound level, impedance, voltage regulation and efficiency. Provide manufacturer's literature describing the product.
E Test report of transformer furnished as hereinafter specified.
F The submittal shall be substantially complete for all items and equipment furnished under this section.
G Individual drawings and data sheets submitted at random intervals will not be accepted for review.
H Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.
B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number

3 Manufacturer's data sheets – When data sheets include more than one model the model(s) used shall be noted
4 Manufacturer's user and maintenance manual(s), including trouble-shooting guidelines
5 Configuration settings
6 Wiring diagrams
7 Voltage ratings
8 Current ratings
9 Calibrated range
10 List of capabilities
11 Environmental ratings
12 NEMA enclosure type
13 Maintenance requirements
14 Installation instructions
15 Repair instructions

C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

PART 2 – PRODUCTS

2.1 DISTRIBUTION TRANSFORMERS

A General
1 Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer and as required for complete installation.
2 Temperature
a 150°C rise
b Self-cooled type
c The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.
3 Impedance shall be manufacturer's standard.
4 All insulating materials used shall be in accordance with NEMA ST20 or NEMA TR27 standards and be rated for 220°C UL component recognized insulation system.
5 The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE and ANSI standards.
6 Primary voltage, secondary voltage, and kVA capacity shall be as shown on the single line or three line diagram(s).

B Manufacturer:
1 Square D
2 General Electric
3 Eaton
4 Approved equal

C Enclosure
1 Dead front
2 Transformers 25 kVA and larger shall be in a heavy gauge, sheet steel, ventilated enclosure
3 Provide wire fabric rodent guard over ventilated openings and designed to prevent accidental access to live parts in accordance with UL, NEMA, and California Electric Code standards for ventilated enclosures.

4 Mounting
a Transformers 15 kVA through 75 kVA shall be designed so they can be either floor or wall mounted.
b Transformers above 75 kVA shall be floor mounted.
5 Corrosion resistant coating
a The completed enclosure shall be degreased and cleaned.
b After the cleaning process is finished, the enclosure shall be phosphatized.
c After the phosphatizing, the enclosure shall receive an electrostatic deposition of polyester powder coating followed by baking to produce a hard durable finish.
1 The minimum thickness of the paint film shall be 2.0 mils.
2 For the exterior of transformer tank, interior and exterior of primary and secondary cable compartments the minimum total dry film thickness shall be 3.5 mils.
3 Paint film shall be uniform in color and free from blisters, sags, flaking and peeling
d Finish shall conform to UL 50 and UL 50E.
e Color shall be ANSI 61 Gray.
f Coat underside surfaces of equipment outdoors or in damp locations with a corrosion resistant coating.

D Sound: Sound levels shall be guaranteed by the manufacturer not to exceed the following.
1 15-50 kVA 45 dB
2 51-150 kVA 50 dB
3 151-300 kVA 55 dB
4 301-500 kVA 60 dB
5 501-700 kVA 62 dB
6 701-1000 kVA 64 dB
7 1000-1500 kVA 65 dB
8 1501-2000 kVA 66 dB

E Efficiency: Transformers shall be low loss type with minimum efficiencies per DOE 2016.

F The transformer(s) shall supply phase shift of 0° or 30°.

G Transformers shall be supplied with quality, full width electrostatic shields resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits.
1 Common Mode: 0 to 1.5kHZ - 120dB; 1.5kHZ to 10kHZ - 90dB; 10kHZ to 100kHZ - 65dB; 100kHZ to 1MHZ - 40dB
2 Transverse Mode: 1.5kHZ to 10kHZ - 52dB; 10kHZ to 100kHZ - 30dB; 100kHZ to 1MHZ – 30dB

H Taps: distribution transformers shall come equipped with the following taps.
1 2.5% FCAN
2 5.0% FCAN
3 2.5% FCBN
4 5.0% FCBN
5 7.5% FCBN
6 10.0% FCBN

I All transformers listed below shall be K-13 rated unless explicitly noted as having a different K rating on the plans.
1 All school transformers
2 Any transformer feeding a load where the load from harmonic producing devices is at least 50% of the transformer’s capacity.

2.2 BUCK-BOOST TRANSFORMERS

A. Where the available voltage is above the acceptable range (including taps), provide and install a bucking transformer.
B. Where the available voltage is below the acceptable range (including taps), provide and install a boosting transformer.
C. Voltage at secondary of buck or boost transformer shall be as close as possible to the nominal voltage of the system. Coordinate secondary voltage of buck or boost transformer, quantity of buck or boost transformers, and use of taps on distribution transformer to achieve this.
D. Transformer shall be compatible with the voltage.
E. Temperature rise, enclosure, efficiencies, and sound levels shall meet the requirements of the distribution transformers.

2.3 CONTROLS TRANSFORMERS

A. Control transformers shall provide secondary voltage within limits of the equipment that it supplies.
B. Transformer shall be completely enclosed or have OEM covers for all exposed, live parts. Covers shall be securely mounted transformer.
C. When transformers are mounted within a control panel, the transformer shall be mounted at the top, near a vent.
D. Whenever possible, the transformer shall be mounted outside of hazardous areas. When not possible, the transformer shall be listed for use within the classification of the hazardous area.
E. Temperature rise, enclosure, efficiencies, and sound levels shall meet the requirements of the distribution transformers.

2.4 CONSTRUCTION

A Transformer coils shall be windings, continuous wound construction, and shall be impregnated with non-hygroscopic, thermosetting varnish.
B All cores shall be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. Cores for transformers greater than 500kVA shall be clamped utilizing insulated bolts through the core laminations to ensure proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.
C The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
D The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

PART 3 – EXECUTION

3.1 ANCHORING

A Install transformers as indicated, complying with manufacturers written instructions, applicable requirements of CEC, NEMA, ANSI, and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

B Floor and roof mounted transformers shall be mounted on steel plates cemented to neoprene pads with a bolt hole through both. Refer to details. Conduit entering transformers shall be isolated from case with oversize hole, ground wire, and rubber grommet.

C Anchor transformer to concrete pad with 3/4" minimum diameter anchor bolts. Bolts and washers shall be galvanized. Strength of materials used to secure the transformer shall be sufficient to resist shear and uplift produced by force equal to one half of the equipment mass applied horizontally at center of gravity.

3.2 GROUNDING

Provide equipment grounding connections, sufficiently tight, to assure permanent and effective ground, for transformers as indicated.

3.3 TESTING

Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with re-testing.

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

Lighting and Appliance Panelboards

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Division 1
  1 Section 013300: Submittal Procedures
  2 Section 014100: Regulatory Requirements
  3 Section 016000: Product Requirements
  4 Section 017700: Execution and Closeout Procedures
  5 All other included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A Published specifications standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.
B California Electrical Code
C California Building Code
D Institute of Electrical and Electronic Engineers (IEEE)
  1 IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
  2 IEEE 100: The Authoritative Dictionary of IEEE Standards Terms
  3 IEEE C2 National Electrical Safety Code
  4 IEEE C37.13: Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
  5 IEEE C37.20.1: Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
  6 IEEE C37.90.1: Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
  7 IEEE C57.13: Standard Requirements for Instrument Transformers
E National Electrical Manufacturers' Association
  1 NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)
  2 NEMA PB 2.1: General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 V or Less
F National Electrical Testing Association (NETA)
  1 NETA ATS: Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
G Underwriters' Laboratories (UL)
  1 UL 50: Enclosures for Electrical Equipment, Non-environmental Considerations
  2 UL 50E: Enclosures for Electrical Equipment, Environmental Considerations
  3 UL 467: Grounding and Bonding Equipment
  4 UL 486A: Wire Connectors
  5 UL 486B: Wire Connectors
  6 UL 486E: Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
  7 UL 489: Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
  8 UL 891: Switchboards
  9 UL 1053: Ground-fault Sensing and Relaying Equipment
  10 UL 1059: Terminal Blocks

11 UL 1558: Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
12 UL 60947-1: Low-Voltage Switchgear and Controlgear – Part 1: General Rules
13 UL 60947-7-1: Low-voltage switchgear and controlgear – Part 7-1: Ancillary equipment - Terminal blocks for copper conductors
14 UL 60947-7-2: Low-Voltage Switchgear and Controlgear - Part 7-2: Ancillary Equipment - Protective Conductor Terminal Blocks for Copper Conductors

1.4 QUALITY ASSURANCE

A Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
B Supply equipment and accessories new, free from defects.
C Supply equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state and local codes.
D Items of a given type shall be the products of the same manufacturer.
E Ship equipment in its original packages to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
F Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.
G Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

1.5 SUBMITTALS

A Submit under provisions of Section 013000 or 013300.
B Submittals shall include the following:
1 Table of contents
2 A complete set of detailed manufacturer’s specifications describing and illustrating all standard and special components and materials
3 Part numbers
4 Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5 Maintenance instructions and intervals
6 Calibration procedures and intervals
C Submit shop drawings that include:
1 Complete fabrication details
2 Elevations and sections of enclosure(s)
3 Dimensions of enclosure(s)
4 Space available for conduits
5 Voltage, ampacity, short circuit, and enclosure ratings
6 Short circuit withstand ability of bus and lowest rated device,
7 Circuit schedule showing circuit number, device description, circuit breaker frame ampere rating and trip or fuse clip ampere rating
8 Termination lug size
9 Feeder identification
10 Single line diagram
11 Include both elementary diagram and terminal to terminal wiring diagrams.
D Electronic submittals shall be searchable
E The submittal shall be substantially complete for all items and equipment furnished under this section.
F Individual drawings and data sheets submitted at random intervals will not be accepted for review.

G Substitutions: Items of same function and performance shall be in conformance with Division 1. The Contractor shall provide a comparison of the proposed substitute with the specified equipment for review by the Engineer.
H Submit field test and operations check report for circuit breakers under provisions of Section 260500.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.
B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number
3 Manufacturer's data sheets – When data sheets include more than one model the model(s) used shall be noted
4 Manufacturer's user and maintenance manual(s), including trouble-shooting guidelines
5 Configuration settings
6 Wiring diagrams
7 Voltage ratings
8 Current ratings
9 List of capabilities
10 Environmental ratings
11 NEMA enclosure type
12 Maintenance requirements
13 Installation instructions
14 Repair instructions
C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A Square D Company
B General Electric
C Eaton/Cutler-Hammer
D Approved equal

2.2 TYPE NQ PANELBOARD

A Interior
1 Shall be type NQ panelboard or approved equal rated for $240V_{AC}/48V_{DC}$ maximum. Continuous main current ratings, as indicated on associated schedules, not to exceed 600 amperes maximum.
2 Minimum short circuit current rating: 22,000 AIC as indicated in rms symmetrical amperes at $240V_{AC}$.
3 Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be copper. Bussing shall be copper as standard construction.

4 Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.

B Main Circuit Breaker

1 Main circuit breakers shall have an over-center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40°C ambient environment. Thermal elements shall be ambient compensating above 40°C.

2 Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker which allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

3 Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.

4 Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors 90°C rated wire, sized according to the 75°C temperature rating per CEC Table 310-16.

C Enclosures

1 Type 1 Boxes

a Boxes shall be galvanized steel constructed in accordance with UL 50 requirements.

b Boxes shall have removable end walls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

c Box width shall be 20 in wide.

2 Type 1 Fronts

a Front shall meet strength and rigidity requirements per UL 50 standards.

b Front shall have cylindrical tumbler type lock with catch and spring-loaded stainless steel door pull. All lock assemblies shall be keyed alike. Two (2) keys shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

c All electrical busses shall be copper.

3 Type 3R, 5, and 12

a Enclosures shall be constructed in accordance with UL 50 requirements

b All doors shall be gasketed and equipped with a tumbler type vault lock. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

c Maximum enclosure dimensions shall not exceed 20 in wide and 6.5 in deep.

2.3 TYPE NF PANELBOARD

A Interior

1 Shall be type NF panelboard for 480Y/277V_{AC} maximum. Continuous main current ratings, as indicated on associated schedules, not to exceed 600 amperes maximum.

2 Minimum Short Circuit Rating: 14,000 as indicated rms symmetrical amperes at 480Y/277V_{AC}.

3 Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall

be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be copper. Bussing rated for 600 amperes shall be copper as standard construction.

4 Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.

B Main Circuit Breaker

1 Main circuit breakers shall have an over-center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40°C ambient environment. Thermal elements shall be ambient compensating above 40°C.

2 Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker which allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

3 Circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.

4 Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 90°C rated wire, sized according to the 75°C temperature rating per CEC Table 310-16.

C Enclosures

1 Type 1 Boxes

a Boxes shall be galvanized steel constructed in accordance with UL 50 requirements.

b Boxes shall have removable end walls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

2 Type 1 Fronts

a Front shall meet strength and rigidity requirements per UL 50 standards.

b Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

3 Type 3R, 5, and 12

a Enclosures shall be constructed in accordance with UL 50 requirements

b All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional trunk type latches. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

c Maximum enclosure dimensions shall not exceed 21 inches wide and 8 inches deep.

2.4 ENCLOSURE FINISH

A The completed enclosure shall be degreased and cleaned.

B After the cleaning process is finished, the enclosure shall be phosphatized.

C After the phosphatizing, the enclosure shall receive an electrostatic deposition of polyester powder coating followed by baking to produce a hard durable finish.

1 The minimum thickness of the paint film shall be 2.0 mils.

2 For the exterior of transformer tank, interior and exterior of primary and secondary cable compartments the minimum total dry film thickness shall be 3.5 mils.

3 Paint film shall be uniform in color and free from blisters, sags, flaking and peeling

D Finish shall conform to UL 50 and UL 50E.

E Color shall be ANSI 61 Gray.

F Coat underside surfaces of equipment outdoors or in damp locations with a corrosion resistant coating.

2.5 NAMEPLATES

Provide and install nameplates per Section 260500.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install all equipment per manufacturers' instructions.

B. Test all equipment per manufacturer's instructions.

C. Mount panelboards with center of top circuit breaker handle no higher than 78" above finished floor. Install flush mounted panelboards as indicated on architectural interior elevation drawings. Provide all necessary blocking, channels and other hardware for securing panelboards to wall, column or other parts of building structure.

D. Submit three copies of the certified list for permanent record to be referenced to in the event of failure of any motor either within or beyond expiration of the warranty period.

3.2 GROUNDING

A. Ground equipment per manufacturer's instructions, Section 260500, and applicable codes.

B. Minimize resistance from device to ground.

C. Resistance from device to ground shall not exceed 25 ohms.

3.3 LOAD BALANCING

If the contractor changes circuiting from the panel schedule on the approved plans, the contractor shall be responsible to ensure that the loads on any two phases differ by no more than 5%.

3.4 IDENTIFICATION

A Provide nameplate identifying panel on exterior of panel per requirements in Section 260500.

B Provide type written panel schedule on interior of door.

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

Materials, equipment fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction, for the following:

A Wiring devices
B Terminal cabinets
C Power distribution terminal blocks

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Division 1
  1 Section 013300: Submittal Procedures
  2 Section 014100: Regulatory Requirements
  3 Section 016000: Product Requirements
  4 Section 017700: Execution and Closeout Procedures
  5 All other included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS

Published specification standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.

A California Building Code
B California Electrical Code
C Underwriters' Laboratories
  1 UL 20: General Use Snap Switches
  2 UL 50: Enclosures for Electrical Equipment, Non-environmental Considerations
  3 UL 50E: Enclosures for Electrical Equipment, Environmental Considerations
  4 UL 111: Multi-Outlet Assemblies
  5 UL 231: Power Outlets
  6 UL 486A: Wire Connectors
  7 UL 486B: Wire Connectors
  8 UL 486E: Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
  9 UL 498: Attachment Plugs and Receptacles
  10 UL 514A: Metallic Outlet Boxes
  11 UL 514C: Nonmetallic Outlet Boxes, Flush-device Boxes, and Covers
  12 UL 514D: Cover Plates for Flush-mounted Wiring Devices
  13 UL 943: Ground Fault Circuit Interrupters
  14 UL 1681: Wiring Devices Configurations
  15 UL 1773: Standard for Termination Boxes
  16 UL 1953: Power Distribution Terminal Blocks
  17 UL 2255: Standard for Receptacle Closures
  18 UL 2682: Switch Rated Plugs and Receptacles

1.4 QUALITY ASSURANCE

A Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
B Supply equipment and accessories new, free from defects.
C Equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state and local codes.

D Items of a given type shall be the products of the same manufacturer.
E Deliver, store and protect products under provisions of Section 016200.
F Ship equipment in its original packages, to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
G Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.
H Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

1.5 SUBMITTALS

A Submit under provisions of Section 013000 or 013300.
B Submittals shall include the following:
1 Table of contents
2 A complete set of detailed manufacturer’s specifications describing and illustrating all standard and special components and materials
3 Part numbers
4 Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5 Maintenance instructions and intervals
6 Calibration procedures and intervals
7 A complete set of drawings for any special items
8 A single line block diagram showing exactly the manner in which the contractor proposes to layout the system.
9 Wiring diagrams
10 Illustrations and scale drawing of the racks, equipment layouts etc.
11 Drawings shall include designations, dimensions, operating controls, instruments, riser diagrams, routing diagrams etc.
12 The contractor shall also submit a copy of his valid state contractor's license and show proof that he is a distributor of the submitted equipment.
C Electronic submittals shall be searchable
D The submittal shall be substantially complete for all items and equipment furnished under this section.
E Individual drawings and data sheets submitted at random intervals will not be accepted for review.
F Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.
B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number
3 Manufacturer’s data sheets – When data sheets include more than one model the model(s) used shall be noted
4 Manufacturer’s user and maintenance manual(s), including trouble-shooting guidelines
5 Configuration settings
6 Wiring diagrams
7 Voltage ratings
8 Current ratings
9 List of capabilities
10 Environmental ratings
11 NEMA enclosure type

12 Maintenance requirements
13 Installation instructions
14 Repair instructions

C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

PART 2 – PRODUCTS

2.1 WIRING DEVICES

A Wall (Local) Switches
1 Totally enclosed
2 AC rated
3 20A rated
4 Silent type, unless noted otherwise on the plans
5 Manufacturers
a Hubbell Premise Wiring
b Leviton
6 Industrial Grade or Extra Heavy Duty Specification Grade

B Receptacles
1 Duplex receptacles shall be 20A, $125V_{AC}$ rated, 3-wire, grounded
2 Receptacle shall include a LED that indicates it has power.
3 Receptacles shall be tamperproof.
4 Manufacturers
a Hubbell Premise Wiring
b Leviton
5 Industrial Grade or Extra Heavy Duty Specification Grade
6 Exterior receptacle plates shall have steel, weatherproof, vandal-resistant while-in-use cover with key lockable/locking cover with keys to match owner standards.
7 All automatically switched receptacles shall be marked per 2017 NEC 406.3(E).

C Other special purpose receptacles shown on Drawings shall be of same quality.

D GFI receptacles shall self test every 3 seconds and indicate if the GFI protection has passed or failed the test.

E Wall Plates: Satin finish stainless steel

F Switch and receptacle colors shall be as noted below unless otherwise specified.
1 General purpose receptacles Gray
2 Isolated Ground (IG) receptacle: Orange
3 Equipment on emergency system: Red
4 Receptacle with surge suppression: Blue
5 Isolated ground receptacles with feature dependant color (other than orange) shall have orange triangle.
6 Follow the facility has a color code scheme if the facility has one. Verify with owner.

2.2 TERMINAL CABINETS

A Construction
1 Fabricated from code gauge steel, size as indicated on drawings, with flush latch and concealed hinges and mounting screws.
2 Enclosure for flush mounted cabinets shall be designed for flush mounting.
3 Enclosure for surface mounted cabinets shall be designed for surface mounting.

B Where size is not indicated, the minimum size shall be 24 inches wide x 30 inches high x 4 inches deep.

C Cabinet shall be Square D “Mono-Flat Fronts”, or approved equal.

D Terminal cabinets shall include a backboard at inside back of cabinet.

1 The backboard shall be 3/4" inch thick plywood
2 Paint backboard with 3 coats of fire retardant paint.

E Provide and install one terminal point for each wire within the terminal cabinet.

F NEMA type:
1 Interior, non-corrosive, non-hazardous (classified) locations: NEMA 1
2 Exterior locations with vents: NEMA 3R
3 Cooled enclosures: NEMA 4
4 Enclosures containing electronics in dusty areas or outdoors: NEMA 4
5 Enclosures in hazardous (classified) locations: NEMA 4 or 4X (corrosive locations) listed for hazardous classification
6 Enclosure in corrosive locations: NEMA 4X
7 All seams on NEMA 3R, 4, and 4X enclosures shall be continuously welded with welds ground smooth.

G Coating
1 The completed enclosure shall be degreased and cleaned.
2 After the cleaning process is finished, the enclosure shall be phosphatized.
3 After the phosphatizing, the enclosure shall receive an electrostatic deposition of polyester powder coating followed by baking to produce a hard durable finish.
a The minimum thickness of the paint film shall be 2.0 mils.
b For the exterior of transformer tank, interior and exterior of primary and secondary cable compartments the minimum total dry film thickness shall be 3.5 mils.
c Paint film shall be uniform in color and free from blisters, sags, flaking and peeling
4 Finish shall conform to UL 50 and UL 50E.
5 Color shall be ANSI 61 Gray.
6 Coat underside surfaces of equipment outdoors or in damp locations with a corrosion resistant coating.

2.3 POWER DISTRIBUTION TERMINAL BLOCKS

A Power distribution terminal blocks (PDTB) shall be finger-safe, NEMA 1 type.

B Conducting material shall be copper.

C Current rating and short circuit rating of PDTBs shall be no lower than upstream overcurrent protective device.

D Terminals
1 Each terminal shall be screw type and be designed for wire size connecting to it.
2 PDTB shall have one terminal for each wire connected to it on both load and line sides.

E Load wire sizes and OCPD shall comply with CEC 240.21(B) and 240.92(B) as well as all other applicable codes.

F PDTBs shall have provisions for panel or DIN rail mounting.

G PDTBs shall be mounted within enclosure unless otherwise noted.

2.4 NAMEPLATES

Provide and install nameplates per Section 260500.

PART 3 – EXECUTION

3.1 GENERAL

A Electric system layouts indicated on the Drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of cable and wiring and the locations of outlets by the structure and equipment served. Dimensions shall be taken from Architectural Drawings.

B Consult all other Drawings. Verify scales and report any dimensional discrepancies or other conflicts to architect, or engineer if no architect is involved, before submitting bid.

C Home runs to panelboards are indicated as starting from the outlet nearest the panel and continuing in the general direction of that panel. Continue such circuits to the panel as though the routes were completely indicated. Terminate homeruns of signal, alarm, and communications system in a similar manner.

D Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of Architect and conform to structural requirements when cutting or boring the structure is necessary or permitted.

E Furnish and install necessary hardware, hangers, blocking, brackets, bracing, runners, required for equipment specified under this section.

F Provide necessary backing required to insure rigid mounting of outlet boxes.

G Outlet boxes shall be plumb.

H Back of wall plates shall be flush with wall finish. Gaps between wall plates and wall or wall plates not parallel to wall are not acceptable.

3.2 CONNECTIONS TO EQUIPMENT

A General:

1 Furnish and install required power supply conduit and wiring to equipment. See below for other wiring required.

2 Install rough-in work for equipment from approved shop drawings to suit the specific requirements of the equipment.

3 Furnish and install magnetic motor starters that are shown on the Drawings or specified under other divisions to be furnished under this division of work. Verify equipment nameplate ratings prior to installation and furnish adequately rated starters for the loads.

4 Furnish and install manual thermal protection for motors not integrally equipped with thermal protection.

5 Furnish and install 120V power to each control panel and time switch requiring a source of power to operate.

B Heating, ventilating, and air conditioning equipment:

1 Coordinate with mechanical contractor for sizes, locations and details of motors, heating units, and control requirements.

2 Provide required power supply conduit and wiring to equipment.

3 Provide a suitable means of disconnect switch immediately ahead of and adjacent to each motor and appliance unless the motor or appliance is located adjacent and within sight of the service panelboard, circuit breaker or switch at a distance allowed by codes. Verify equipment nameplate current ratings prior to installation. Provide a disconnect means at each magnetic motor starter.

4 Provide magnetic motor starters required under this division of work.

5 Provide manual thermal protection for motors not integrally equipped with thermal protection.

6 Line and low voltage temperature control and interlock wiring, conduit, and required connections are a part of other divisions unless specifically shown or noted on the Drawings as to be furnished under this section.

7 Provide 120V power supply to control panels, time switch furnished and installed under other divisions of work.

8 Furnish and install 120V power to each duct detector scheduled for operation of fire dampers or shut down of mechanical equipment. Coordinate the exact quantity and locations with the mechanical drawings.

C Plumbing and other contractor-furnished and Owner-furnished equipment:

1 Required power and control conduit, wiring and connections are included under this section of the work. Control sensing and alarm devices will be furnished under the respective section of the contract supplying the equipment unless noted otherwise. These devices will be located in pipes, ducts, vessels, tanks, etc., and will be mounted in a place by the Contractor furnishing the devices. Other devices shall be mounted under this section of the work.

2 Control panels for packaged equipment will be furnished under the respective section of the contract supplying the equipment unless otherwise noted. Installation and connection of the control panels are under this section of the work.

3.3 IDENTIFICATION

Refer to Section 260500.

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

Materials, equipment fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction, for overcurrent protective devices

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Division 1
  1 Section 013300: Submittal Procedures
  2 Section 014100: Regularity Requirements
  3 Section 016000: Product Requirements
  4 Section 017700: Execution and Closeout Procedures
  5 All other included sections under Division 1
B All included sections under Division 26
C Plans
D Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

Published specification standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.

A California Building Code
B California Electrical Code
C Institute of Electrical and Electronic Engineers
  1 IEEE 1015: Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
  2 IEEE 1458: Recommended Practice for the Selection, Field Testing, and Life Expectancy of Molded Case Circuit Breakers for Industrial Applications
D Underwriters' Laboratories
  1 UL 50: Enclosures for Electrical Equipment, Non-environmental Considerations
  2 UL 50E: Enclosures for Electrical Equipment, Environmental Considerations
  3 UL 98: Enclosed and Dead-front Switches
  4 UL 363: Knife Switches
  5 UL 489: Molded-case Circuit Breakers, Molded-case Switches, and Circuit Breaker Enclosures
  6 UL 1066: Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures
  7 UL 2367: Standard for Solid State Overcurrent Protectors

1.4 QUALITY ASSURANCE

A Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
B Supply equipment and accessories new, free from defects.
C Equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state and local codes.
D Items of a given type shall be the products of the same manufacturer.
E Deliver, store and protect products under provisions of Section 016200.
F Ship equipment in its original packages, to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
G Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.

H Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

1.5 SUBMITTALS

A Submit under provisions of Section 013000 or 013300.
B Submittals shall include the following:
1 Table of contents
2 A complete set of detailed manufacturer's specifications describing and illustrating all standard and special components and materials
3 Part numbers
4 Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5 Maintenance instructions and intervals
6 A complete set of drawings for any special items
7 Wiring diagrams
C Electronic submittals shall be searchable
D The submittal shall be substantially complete for all items and equipment furnished under this section.
E Individual drawings and data sheets submitted at random intervals will not be accepted for review.
F Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.
B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number
3 Manufacturer's data sheets – When data sheets include more than one model the model(s) used shall be noted
4 Manufacturer's programming, user, and maintenance manual(s), including trouble-shooting guidelines
5 Configuration settings
6 Wiring diagrams
7 Voltage ratings
8 Current ratings
9 Calibrated range
10 List of capabilities
11 Environmental ratings
12 NEMA enclosure type
13 Maintenance requirements
14 Installation instructions
15 Repair instructions
C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

PART 2 – PRODUCTS

2.1 CIRCUIT BREAKERS

A Circuit breakers shall be constructed in accordance with the following standards:
1 UL 489 or UL 1066

2 Federal Specification W-C-375B/GEN
3 NEMA AB1
4 CSA 22.2, No. 5-M91
5 IEC 157-1
6 BS 4752

B Construction
1 Circuit breakers shall be constructed using glass reinforced polyester insulating material providing superior dielectric strength.
2 Current-carrying components shall be completely isolated from the handle and the accessory mounting area.
3 Breaker contact material shall be a non-weldable silver alloy.
4 Breakers shall have arc-extinguishing chutes.
5 Circuit breakers shall have an over-center, trip-free, toggle operating mechanism which will provide quick-make, quick-break contact action.
6 Multiple pole breakers shall have a common trip element and a single operating handle.
7 Circuit breakers for branch circuits shall be molded case
8 Circuit breakers shall have bolt-on/plug-on type bus connectors.

C Trip type
1 Circuit breakers having a frame size of 150 amperes or less shall have thermal magnetic non-interchangeable, trip-free sealed trip units.
2 Circuit breakers with a frame size of 175 amperes up to 800 amperes shall have interchangeable thermal and adjustable magnetic trip elements with adjustable instantaneous, short-time, and long-time settings.
3 Circuit breakers with a frame size of 800 amperes or greater shall have adjustable electronic trip units with adjustable instantaneous, short-time, and long-time settings.

D There shall be two forms of visible trip indication.
1 The breaker handle shall reside in a position between ON and OFF.
2 In addition, there shall be a red trip indicator appearing in the clear window of the circuit breaker housing.

E Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules.

F Circuit breakers faceplates shall be marked with the following
1 Rated ampacity
2 UL and IEC certification standards
3 Applicable voltage systems and corresponding AIR ratings

G Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 90°C rated wire, sized according to the 75°C temperature rating per CEC Table 310-16.

H Branch circuit breakers rated 30 amperes and below shall be UL Listed to accept 60°C rated wire.

I The interrupting capacity of all main and feeder branch circuit breakers shall be a minimum of 42,000A_{RMS} symmetrical amperes.

J All circuit breakers feeding HVAC units, motors, or circuit breakers supplying loads other than convenience receptacles or lights shall have lockout devices.

K Standard circuit breakers up to 250A at 600V_{AC} shall be UL Listed with HACR ratings.

L All circuit breakers feeding 120V, 15A and 20A branch circuits in dwellings shall be AFCI.

M Circuit breakers with shunt-trip or low voltage release shall be switch duty rated.

N All fixed trip circuit breakers 1200A or greater and adjustable trip circuits breakers with a maximum rating 1200A or greater shall be equipped with one of the following methods to reduce arc flash energy.
1 Zone selective interlocking
2 Differential relaying
3 Arc flash detection and mitigation system in panel/board with the 1200A circuit breaker.

2.2 SAFETY SWITCHES (DISCONNECTS)

A Switches shall be heavy duty type
B Minimum voltage rating shall be 600V.
C Minimum Size
  1 Switches for disconnecting motors shall be sized for the horsepower of for motor(s).
  2 All switches shall be sized per the overcurrent protective device protecting the switch.
D Construction
  1 NEMA 1 for indoors
  2 NEMA 3R or NEMA 4 for outdoors
  3 Handle shall be lockable in the off/disconnected/open position.
E The switch shall include a barrier between the fuse section and the switch section with separate doors for each section. The entire fuse section shall be de-energized when the switch is in the off position.
F Switch shall be equivalent to Square D H-rated series.
G Finish: The entire enclosure shall be finished as follows.
  1 Degreasing
  2 Cleaning
  3 Phosphatizing
  4 Electrostatic deposition of polymer polyester powder coating followed by baking to produce a hard, durable finish.
    a The minimum thickness of the paint film shall be 2.0 mils.
    b Paint film shall be uniform in color and free from blisters, sags, flaking and peeling
  5 Finish shall conform to UL 50 and UL 50E.
  6 Color shall be ANSI 61 Gray.
  7 Coat underside surfaces of equipment outdoors or in damp locations with a corrosion resistant coating

PART 3 – EXECUTION

3.1 GENERAL

A Electric system layouts indicated on the Drawings are generally diagrammatic but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of cable and wiring and the locations of outlets by the structure and equipment served. Dimensions shall be taken from Architectural Drawings.
B Consult all other Drawings. Verify scales and report any dimensional discrepancies or other conflicts to architect, or engineer if no architect is involved, before submitting bid.
C Furnish and install necessary hardware, hangers, blocking, brackets, bracing, runners, required for equipment specified under this section.

3.2 OVER CURRENT PROTECTION DEVICE COORDINATION STUDY

A Contractor shall have a third party provide a coordination study to determine trip settings of circuit breakers and/or appropriate fuse types.
B Fault, circuit overload, etc shall only trip closest circuit breaker or melt closest fuse. No other circuits shall be affected.

END OF SECTION