

O'Connor Hospital Seismic Compliance

2105 Forest Ave., San Jose, CA 95128

Project Manual

Packages

- 1A: Locker Areas / Public Restrooms**
- 1B: Imaging CT / Reading Relocation**
- 1C: Radiation Therapy**
- 1D: Exit Stairs / Egress**
- 2A: Hospital Occupancy Separation / Utility Isolation**
- 3A: CUP – Occupancy Separation / Utility Isolation**
- 4: Utilities**

Design Development - Electrical

Facility #: 10919

OSHPD #:

HGA

Hammel, Green and Abrahamson, Inc.
84 W. Santa Clara Street, Suite 200
San Jose, California 95113
(408) 288-7833

HGA Commission Number
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SECTION 26 00 10 BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section covers general work of all Sections under Division 26.
- B. Provide a complete working electrical installation with all equipment called for in proper operating condition. Documents do not undertake to show or list every item to be provided. When an item not shown or listed is clearly necessary for proper operation of equipment which is shown or listed, provide the item which will allow the system to function properly at no increase in Contract Price.
- C. The Division 26 Specifications and Drawings are complementary; what is called for by one is binding, as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa.
- D. Use the more stringent requirement when specified materials or methods exceed the applicable code standards.
- E. The Drawings that accompany the Division 26 Specifications are diagrammatic. They do not show every offset, bend, conduit body, elbow or junction box that may be required to install work in the space provided and avoid conflicts. Follow the Drawings as closely as is practical and install additional bends, offsets and elbows where needed by local job site conditions. Provide necessary junction boxes to meet code regulations for the allowed number conduit bends. The right is reserved to make minor field order changes in outlet location prior to roughing-in without additional cost to the Owner.
- F. Imperative language is frequently used in Division 26 Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.
- G. All Sections of Division 26, Electrical Specifications, are interrelated. Use Division 26, in its entirety, when interpreting any material, method or direction listed in any Section.
- H. When specified materials or methods exceed the applicable code standards, use the materials or methods specified. When materials or methods specified fall below applicable code standards, replace or modify materials or methods to meet applicable code standards. Do not provide materials or employ methods that do not conform to applicable codes and standards.
- I. The Drawings and Specifications, combined with the calculations, field data, notes, and reports, are the intellectual and real property of Mazzetti. This covers all forms of written and recorded or electronic media. The reuse of these documents without specific permission of the Engineer is prohibited. The Drawings may be employed by the Owner and Contractor for the express use of constructing, commissioning and operating the facility.

1.2 REFERENCES

- A. The General Conditions, Supplementary Conditions, and applicable portions of Divisions 1 and 26 apply to the work of this Section as if printed herein.

- B. Publications and standards listed below form a part of this specification to the extent referenced. The publications and standards are referred to in the text by basic designation only.
1. California Electrical Code (CEC) 2016 Edition.
 2. California Building Code – (CBC) 2016 Edition.
 3. California Mechanical Code (CMC) 2016 Edition.
 4. California Fire Code (CFC) 2016 Edition.
 5. Illuminating Engineering Society of North America (IESNA).
 6. Association of Edison Illuminating Companies.
 7. Insulated Cable Engineers Association (ICEA).
 8. National Fire Protection Association (NFPA).
 9. National Electrical Manufacturers Association (NEMA).
 10. National Electrical Contractors Association (NECA).
 11. American National Standards Institute (ANSI).
 12. Institute of Electrical and Electronic Engineers (IEEE).
 13. Underwriters Laboratories (UL).
 14. State of California Low-Voltage Electrical Safety Orders (CAL/OSHA).
 15. Codes and regulations noted in other Sections in Division 26, applicable State and Local Codes and Ordinances.
 16. American with Disabilities Act – 1994.
- C. If any of the requirements of the above are in conflict with one another, or with the requirements of these specifications, the most stringent requirement shall govern.
- D. If any of the requirements of the drawings or specifications are in conflict with one another, the most stringent requirement shall govern.
- 1.3 SUBMITTALS: Electronic Submittals shall be allowed provided they are acceptable per Division 1 and are formatted, organized and coordinated per this section. PDF format is acceptable.
- A. Comply with the provisions of Division 01 - SUBMITTALS.
 - B. Forward all submittals in related groups. Individual or incomplete submittals are not acceptable.
 - C. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment.
 - D. Identify each submittal item by reference to Specification Section paragraph in which item is specified or Drawing and Detail number.
 - E. Organize submittals in same sequence as they appear in Specification Sections, articles or paragraphs.
 - F. Shop Drawings shall show physical arrangement, construction details and finishes.
 1. Drawings shall be drawn to scale and dimensioned where applicable.
 2. Catalog cuts and published material may be included to supplement scale drawings.

- G. Internal wiring diagrams of equipment shall show wiring as actually furnished for this project with all optional items clearly identified as included or excluded. Clearly identify external wiring connections. Identify and obliterate superfluous material.
- H. Submittal literature, drawings and wiring diagrams shall be specifically applicable to this Project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item. Submittals shall include, but not be limited to those items listed in individual Sections.
 - 1. Include all physical and performance data, including materials, manufacturers names, model numbers, weights, sizes, capacities, performance curves, finishes, colors, accessories and all other data required to completely describe equipment and to indicate complete compliance with Specifications and Drawings.
 - 2. Include with complete submittals above, complete, large scale, dimensioned Shop Drawings, certified by manufacturer, of all major equipment and other equipment as directed by Architect.
 - 3. Include with electrical equipment submittal: to scale electrical room layout including architectural and structural components, electrical equipment proposed, working clearances about and above equipment.
- I. Substitutions: In accordance with Division 01 PRODUCT OPTIONS AND SUBSTITUTIONS.
- J. Re-submittals will be reviewed for compliance with comment made on the original submittal only and should be marked with a resubmittal number and dated. Contractor shall respond in writing to all comments made on submittal review and identify how comment was resolved.
- K. Operating and Maintenance Instructions and Manuals
 - 1. Subsequent to final completions and testing operations, this Division is responsible for instructing the Owners authorized representatives in operation, adjustment and maintenance of electrical plant.
 - 2. Submit three (3) copies of certificate, signed by Owners Representatives, attesting to their having been instructed.
 - 3. Before Owners personnel assume operation of systems, submit three (3) sets of Operating and Maintenance manuals. Manuals shall include information on the operation, maintenance, testing and commissioning of each equipment and system. Bind data in vinyl covered loose-leaf binders with title index tabs identifying items therein to include:
 - a. Switchgear
 - b. Switchboards
 - c. Motor Control Equipment
 - d. Transformers
 - e. ATS's
- L. Shop drawings shall contain job title and reference to the applicable drawing and/or specification article and OSHPD number.
- M. Submit details and calculations for support and anchors that are not specifically detailed on the drawings. All calculations must meet 2016 CBC.
 - 1. Provide details and calculations for electrical equipment:
 - a. Having an operating weight over 400 pounds or more and mounted directly to the floor.
 - b. Having an operating weight over 20 pounds and suspended from the roof, floor, or wall or supported by vibration isolation devices.

2. Once these details and calculations have been reviewed by the Architect, submit them to OSHPD and obtain their approval.
 - a. Where pre-approved bracing systems will be employed, submit:
 - (1) OSHPD identification number.
 - (2) System component brochure describing components used and detailed installation instructions.
 - (3) Loads to be transmitted to the structure at anchor points.
 - (4) Prove the systems meet CBC 2016 section 1632A.6
 - b. Where anchorage, support, and bracing are not detailed on the drawings, and pre-approved systems are not used, submit details and calculations of proposed systems. Include:
 - (1) Detailed drawings showing system to be installed, stamped by a Structural Engineer registered in the State of California.
 - (2) Calculations, stamped by a Structural Engineer registered in the State of California.
 - (3) A certification on the calculation sheet stating, "These calculations demonstrate that the system detailed complies with the requirements of Chapter 16 of the California Building Code. The system on which this bracing will be applied is rigid as defined in Chapter 16."
 - (4) Obtain OSHPD approval for the proposed system should a pre-approved system not be utilized.
 - c. Anchorage and Supports
 - (1) Where equipment substitutions change the weight, size, configuration, or other aspects of systems and equipment that will affect the performance of anchorages and/or supports, submit calculations for proposed anchors and supports, and install them as shown in these calculations. These calculations shall include the same certification and engineer's stamp as required above for seismic bracing. Obtain OSHPD approval for all electrical equipment bracing.
 - (2) Where substitutions will have no effect on anchors and supports detailed on Contract Documents, submit information on sizes, weights, center of gravity and other relevant information to demonstrate this fact.
 - d. Provide all equipment with special seismic certification per CBC 2016 Section 1708A and ASCE/SE17-05 Section 13.2.2 Note 6. Refer to OSHPD CAN 2-1708A.5 for additional information.

1.4 RECORD DRAWINGS

- A. Coordinate with the requirements of Division 01 SUBSTANTIAL AND FINAL COPLETION.
- B. Provide record Drawings that fully represent installed conditions including actual location of outlets, true panelboard connections following phase balancing routines, correct conduit and wire sizing as well as routing, revised fixture schedule listing actual manufacturer and products installed, and revised panelboard schedules.
- C. Maintain up to date record set of electrical prints during the course of construction. The prints are subject to monthly review by the Owners representative to ascertain that they are current. If not current, monthly payments may be withheld.
- D. Prior to Substantial Completion, obtain from the Architect a complete set of electronic CADD drawings. Record all revisions to these drawings to indicate as-built conditions. Indicate all changes, including RFIs, on this set of documents. Submit one set of PDF drawings or blueprints of

these revised drawings for review with all changes clouded. Make necessary changes and deliver to Architect one set of reproducible and one electronic copy prior to Final Completion.

1.5 QUALITY ASSURANCE

- A. Materials and Systems
 - 1. Labels: Provide materials listed and labeled by Underwriters! Laboratories or testing firm acceptable to authority having jurisdiction, where listing service is normally provided for product.
 - 2. Materials: Provide new and ship to jobsite in original manufacturer's containers or bundles.
 - 3. Provide materials and equipment that comply with CEC, NEMA and ANSI standards.
- B. Workmanship: Arrange Work to obtain coordinated installation.
- C. Code Compliance: Comply with applicable codes, laws, rules, regulations, and standards of applicable code-enforcing authorities.
- D. Electrical Acceptance Tests and Reports
 - 1. Electrical Acceptance tests shall be performed per Section 26 00 80 and the individual sections where applicable.
 - 2. Test reports: All test forms, test results and test reports shall be typed in their final form.
 - 3. Operational tests: Before acceptance tests are performed, demonstrate to the Architect that all systems and components are complete and fully operational. Perform operational tests on all equipment to determine compliance with Specifications.
- E. All major equipment including but not limited to the following items shall be inspected for compliance with the reviewed shop drawings and requirements of the contract documents. Contractor shall notify the Owner's Representative upon arrival of the equipment to the job site and provide all assistance for such inspection prior to the equipment installation.
 - 1. Switchboard.
 - 2. Panelboards
 - 3. Medium voltage transformer.
 - 4. Lighting fixtures, including controls.
 - 5. Grounding.
 - 6. Conductors and cables
- F. Provide quality assurance and quality control plans and procedures for review.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Coordinate with the requirements to Division 01 - PRODUCT OPTIONS AND SUBSTITUTIONS.
- B. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no increase in Contract Sum.
- C. Protect equipment from weather, moisture and dust by appropriate covering. Provide and maintain heating within equipment environment to prevent condensation.

1.7 DRAWINGS AND COORDINATION WITH OTHER WORK

A. Drawings

1. For purposes of clarity, legibility, Drawings are essentially diagrammatic.
2. Exact routing of wiring and locations of outlets, panels, etc., shall be governed by structural conditions, obstructions and existing conditions. Architect reserves right, at no increase in price, to make any reasonable change in locations of electrical items, exposed at ceiling and/or on walls, to group them into orderly relationships and/or increase their utility. Contractor shall verify Architects requirements in this regard prior to roughing-in.
3. Dimensions, location of doors, partitions, and similar physical features shall be taken from architectural Drawings for exact location of outlets to center with Architectural features, panels, etc., at the approximate location shown on Electrical Drawings.
4. Locations shown on Architectural Ceiling Drawings or on wall elevations shall take precedence over electrical plan locations.
5. Verify dimensions and the correct location of equipment and coordinate with other trades for any requirement before proceeding with the roughing-in of connection.
6. Mounting heights of brackets, outlets, etc., shall be as required to suit equipment served.
7. Drawings indicate, generally, routes of all branch circuits. All runs to panels are indicated as starting from nearest outlet, pointing in direction of panel. Continue all such circuits to panel as though routes were indicated in their entirety.
8. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any Work, carefully check and verify all dimensions, sizes, etc., with the Drawings to see that the equipment being installed will fit into the spaces provided.
9. Locations of Openings: Locate all chases, shafts and openings required for the installation of the electrical Work during framing of the structure. Do any cutting and patching required due to improperly located or omitted openings with the approval of the Owner's Representative, who must also approve any additional changes resulting from relocation or omission of openings. Cutting or drilling in any structural member is prohibited without prior written approval of the Owner.
10. Access to Equipment: Locate starters, switches, receptacles, cable tray and pullboxes to provide easy access for operation, repair, and maintenance, and if concealed, provide layout of access doors. Access doors shall be furnished and installed by the framer.
11. The Contractor shall be responsible for verifying that equipment being provided by him will fit dimensionally in locations shown on Drawings.
12. Circuit "tags" on the Electrical Drawings in the form of arrows are used to indicate home runs of raceways to electrical distribution points. These tags show the circuits in each home run and the panel designation. Do not combine circuits other than those shown on the Drawings. Show the actual circuit numbers on the finished record drawing, and on the panel directory card. Provide an insulated grounding conductor in every power circuit.
13. The Drawings do not indicate the exact number of wires in each conduit for the branch circuit wiring. Provide the correct quantity of wires as indicated by: the circuit numbers indicated, wiring diagrams, and by applicable requirements of the CEC. Provide a grounding conductor in every power circuit.
14. Electrical Drawings are diagrammatic and shall not be scaled for exact sizes. Adjust location of conduits, panels, equipment, pull boxes and fixtures to accommodate the work and to prevent interferences.
 - a. Lines which pitch have right-of-way over those that do not. Lines whose elevation cannot be changed have right-of-way over lines whose elevations can.

- b. Make offsets, transitions, and changes in direction in raceways as required to maintain proper headroom pitch of sloping lines.

B. Coordination

1. Work out all tight conditions involving Work under this Division and Work in other Divisions in advance of installation. If necessary, and before Work proceeds in these areas, prepare supplementary 3D Drawings under this Division for review, showing all Work in tight area. Provide supplementary Drawings and additional Work necessary to overcome tight conditions.
2. Differences or disputes concerning coordination, interference or extent of Work between Divisions shall be decided by Contractor. His decision, if consistent with Contract Documents requirements, shall be final.
3. Coordinate electrical power and line voltage control wiring requirements of mechanical equipment with requirements in Division 25. Low voltage wiring that is not shown as by electrical contractor shall be the responsibility of the low voltage controls contractor including all conduit if not shown specifically in drawings as by Electrical Contractor.
4. Coordinate electrical power and line voltage power supply wiring requirements of other low voltage system requirements with respective specifications section. Including but not limited to: Low voltage wiring that is not shown as by electrical contractor shall be the responsibility of the low voltage system awarded contractor including all conduit if not shown specifically in the low voltage system drawings as by Electrical Contractor.
5. Where conflict exists between rough-in shown on drawings and that shown or required by equipment to be installed, obtain clarification from Architect and provide rough-in as directed.
6. Provide templates, information and instructions to other Divisions to properly locate holes and openings to be cut or provided for Electrical Work.

- C. Large Scale Layout Drawings:** In accordance with requirements of Division 01, prepare large scale detailed layout Drawings showing locations of equipment, conduit runs, panels, and all other elements of electrical systems where required by other Sections of this Division, plus sections of all congested areas to show relative position and spacing of affected elements. All symbols and designations used in preparing record Drawings shall match those used in Contract Drawings.

D. Equipment Rough-In

1. Rough-in locations shown on Electrical Drawings for equipment furnished by Owner and for equipment furnished under other Divisions are approximate only.
 - a. Obtain exact rough-in locations from following sources:
 - (1) From shop drawings for Contractor-furnished and installed equipment.
 - (2) From Architect for Owner-furnished Contractor-installed equipment.
2. Verify electrical characteristics of equipment before starting rough-in. Where conflict exists between equipment and rough-in shown on Drawings obtain clarification from Architect and provide as directed.
3. Unless otherwise shown or specified, provide direct raceway and conductor connections from building wiring system to equipment terminals for direct connected equipment which is Contractor furnished and Contractor installed, Owner furnished and Contractor installed.
4. Provide plug-in receptacle cap for cord-connected equipment, which is Contractor furnished and Contractor installed, Owner furnished and Contractor installed. Provide new cord and cap if required on Owner furnished and Contractor installed equipment.
5. Provide disconnect switches, flush type in finished spaces, where shown or required by code for direct connected equipment.

1.8 SITE VISITATION

- A. Coordinate with the requirements of Bidding and Contract Requirements, Instruction To Bidders.
- B. Visit the site prior to bidding and become familiar with existing conditions and other factors that may affect the execution of work. Include all related costs in the initial bid proposal.

1.9 SCHEDULE OF WORK

- A. Coordinate with the requirements of Division 01 — CONSTRUCTION PLANNING AND SCHEDULING.
- B. Provide full-time supervisory staff to coordinate and maintain work force for project work sequencing requirements.
- C. Arrange work to comply with schedule of construction requirements.

1.10 WARRANTY

- A. Coordinate with the requirements of Division 01 — SUBSTANTIAL AND FINAL COMPLETION.
- B. Provide at least one-year guarantee (or more as indicated elsewhere) for installed project materials and equipment unless otherwise indicated in other Division 26 Sections. Guarantee period shall be effective from time of work acceptance as defined in Division 1.
 - 1. Any Electrical gear that is set early and used during construction shall not reduce the warranty in any form. The warranty shall begin when the equipment is turned over to owner at substantial completion.

1.11 DEFINITION OF TERMS

- A. The following list of terms as used in the Division 26 documents shall be defined as follows:
 - 1. Provide: Shall mean furnish, install and connect unless otherwise indicated.
 - 2. Furnish: Shall mean purchase and deliver to project site.
 - 3. Install: Shall mean to physically install the items in-place.
 - 4. Connect: Shall mean make final electrical connections for a complete operating piece of equipment.
 - 5. Equal: Shall be of the same quality, appearance and utility to that specified, as determined by the Owner's Representative. The Contractor bears the burden of proof of equality.
 - 6. Exposed: Shall mean exposed to view after construction is completed.
 - 7. Utility Area: Shall mean electrical, mechanical and communications equipment rooms, elevator machine room and equipment yards.
 - 8. As directed: Shall be as directed by the Owner's Representative.
 - 9. As required: Shall be as required by applicable code requirements, good building practice, the conditions prevailing, the Bid Documents, the Owner, or the Owner's Representative.
 - 10. As selected: Shall be as selected by the Owner's Representative.
 - 11. Owner's Representative: Shall mean Architect.

1.12 TRAINING

- A. Provide a period of 40 hours for the necessary training program and instructions to the selected Owner's employees for the electrical system for the entire building in addition to what is specified in each section.

1.13 FEES AND PERMITS

- A. Obtain and pay for all necessary permits and inspection fees required for electrical installation with the exception of OSHPD.
- B. Coordinate work with local utility companies. Costs incurred relative to power service and telephone service shall be paid by the Owner.

PART 2 - PRODUCT

2.1 GENERAL

- A. Refer to applicable Division 26 Sections for complete product specifications.
- B. All switchgear, switchboards, motor control centers, transformers, panelboards and circuit breakers shall be of the same manufacturer.
- C. All wiring devices such as switches, receptacles, etc. shall be of the same manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

- A. Manufacturers' names and model numbers used for materials, processes or equipment in Division 26 provide the standards of quality, utility and appearance.

2.3 SUBSTITUTIONS

- A. Coordinate with the requirements of Division 01 - PRODUCT OPTIONS AND SUBSTITUTIONS.
- B. Products or systems listed as "no substitutions!": Provide as specified.
- C. Products or systems noted as "or equal": A product or system of equivalent design, construction and performance will be considered. Submit all pertinent data and product information for review. Provide the specified products or systems if proposed substitution is found unacceptable.

2.4 MATERIALS FURNISHED

- A. New, bearing label of Underwriters Laboratories, or other testing laboratory acceptable to authority having jurisdiction, where labeling exists for the class of equipment.
- B. Provide equipment of one manufacturer, alike in appearance and function.

- C. For equipment specified by manufacturer's number, include all accessories, controls, etc., listed in catalogue as standard with equipment. Furnish optional or additional accessories as specified.
- D. Where no specific make of material or equipment is mentioned, use any product of reputable manufacturer that conforms to requirements of system and other applicable specification sections.
- E. Equipment and material damaged during transportation, installation, or operation is considered as totally damaged. Replace with new. Variance from this permitted only with written approval.
- F. Provide an authorized representative to constantly supervise work specified in this Division, check all materials prior to installation for conformance with Drawings, Specifications, and reviewed Shop Drawings.
- G. Manufacture: Company specializing in manufacturing specified products for at least three years.

PART 3 - EXECUTION

3.1 GENERAL METHODS

- A. Examine site related work and surfaces before starting work of any Section.
- B. Report to Architect, in writing, conditions which will prevent proper execution of this work.
- C. Beginning work of any Section without reporting unsuitable conditions to Architect constitutes acceptance of conditions by Contractor.
- D. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.

3.2 CONNECTIONS TO EXISTING WORK

- A. Install new work and connect to existing work with minimum interference to existing facilities.
- B. Provide temporary shutdowns of existing services only with written consent of Owner. Perform this work at no additional charges and at times that do not interfere with normal operation of existing facilities.
- C. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
- D. Do not interrupt alarm and emergency systems without consent of Owner.
- E. Connect new work to existing work in neat and acceptable manner.
- F. Restore existing disturbed work to original condition including maintenance of wiring and continuity as required.

3.3 INSTALLATION

- A. Provide a complete properly operating system for each item of equipment called for under this work. Installation shall be in accordance to equipment manufacturer's instructions, the best industry practices and the contract documents.
- B. Make installation in a neat, finished and safe manner, according to the latest published NECA Standard of Installation under competent supervision.
- C. Manufacturer's Directions: Follow in all cases where manufacturers of articles used furnish directions covering points not specified or shown.
- D. Review Shop Drawings for work done by other trades.
- E. Verify all dimensions by field measurements.
- F. Arrange for inserts, chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- G. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed. Sleeves and chases in structural members shall follow the requirement of Division 3.
- H. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- I. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- J. Install systems, materials, and equipment to comply with approved submittal data, including coordination drawings, to greatest extent possible. Comply with arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
- K. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- L. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Rearrangement or relocation of electrical work that block access to mechanical duct inspection or servicing panels, valves, fire damper actuators and similar apparatus shall be done at Contractor's own expense.
- M. Coordinate electrical systems, equipment, and materials installations with other building components.
- N. Provide layout for all access panels required for the electrical installation. Access panels shall be provided by the framer. Electrical contractor shall coordinate the installation where devices or equipment are concealed behind finished surfaces.

- O. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- P. Coordinate the exact placement of all concrete foundations or related concrete pads with concrete contractor that relate to electrical equipment.
- Q. Provide minimum 4" concrete housekeeping pads for all floor mounted electrical equipment. Pad shall be level with zero bubble throughout.
- R. Conduit Systems
 - 1. Worked into complete, integrated arrangement with like elements to make Work neat appearing, finished.
 - 2. Run concealed, except as shown or noted otherwise. Where exposed, install parallel with walls or structural elements: vertical runs plumb; horizontal runs level or parallel with structure as appropriate: groups racked together neatly with straight runs and bends both parallel and uniformly spaced.
 - 3. Install as high as practicable to maintain adequate head room shown or required. Coordinate with Work of other Divisions to achieve proper headroom.
 - 4. Flash and counter-flash all conduits through roof in accordance with requirements of Section 07 6200. Roof jacks furnished by electrical contractor, installed by roofing contractor. Counter flashing provided by others.
 - 5. Clearance: Do not obstruct spaces required by code in front of electrical equipment, access doors, etc.
- S. Penetrations
 - 1. Pack space between conduit, sleeve in walls with non-combustible materials.
 - 2. Make penetrations through floors water-tight with non-hardening sealant even though concealed within wall or furred space when not using a fire stopping assembly.
 - 3. Make penetrations through any damp-proofed/water-proofed surfaces damp-proof/waterproof by appropriate means to maintain integrity of system penetrated.
 - 4. Seal around penetrations with fireproofing material to maintain integrity of fire rating where occurs.
 - 5. Seal around penetration with acoustical material to maintain the integrity of acoustical rating where occurs.
- T. Coordinate and locate light fixtures located in rated ceilings. Assist in supplying dimensions for each light fixture to framing contractor for a complete installation. Coordinate all wall openings required for electrical panelboards and like items to maintain integrity of rated wall or ceiling construction.

3.4 NOISE CONTROL

- A. Electrical contractor to provide sound pads, all other acoustical sealants to maintain the sound rating of the wall is provided by others.
- B. Back to back or straight through boxes are not permitted unless specifically noted on the drawings.
- C. Seal raceway penetrations through sound rated walls.
- D. Do not install contactors, transformers, starters and similar noise producing devices on walls common to occupied spaces unless specifically noted on the drawings. Where such devices must

be mounted on common walls, install using shock mounted or isolated methods to prevent the transmission of device inherent noise to the occupied space.

- E. Ballasts, contactors, starters, transformers and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

3.5 FIRE WALL PENETRATIONS

- A. Perform necessary fire rated wall sealing for the electrical work in compliance with the California Building Code and instructions in Division 7.
- B. Coordinate the installation of all electrical equipment installed in all fire wall rating assemblies. Provide framer with all opening sizes and coordinate drywall placement with framer to maintain fire rated assembly integrity.
- C. Where raceways penetrate floors, ceilings, ducts, chases and fire walls, provide fire stopping to maintain integrity of the fire assembly. Fire stopping method shall be approved by the authority having jurisdiction.
- D. Where electrical boxes with total area exceeding 16 square inches are located in fire resistive walls, fire stopping shall be provided to maintain integrity of the fire assembly.
- E. Where electrical boxes are installed on opposite sides of a rated wall, horizontal separation between the boxes shall be a minimum of 24-inches. Horizontal separation of these boxes may be less than 24-inches if a UL approved protective material is utilized.
- F. Electrical boxes shall not be installed back to back in rated walls.
- G. The aggregate surface area of the boxes shall not exceed 100 sq in per 100 sq ft of wall surface.

3.6 EQUIPMENT CONNECTIONS

- A. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices and labor necessary for a finished working installation.
- B. Verify the location and method for connecting to each item of equipment prior to roughing-in. Check voltage and phase of each item of equipment before connection.
- C. Make motor connections for the proper direction of rotation.
- D. Furnish all code required disconnects under this work, whether specifically shown or not.

3.7 EQUIPMENT SUPPORT

- A. Perform necessary equipment seismic anchorage in compliance with the 2013 CBC as well as any requirements from the local agency having jurisdiction.
- B. Securely fasten to the structural floor all freestanding electrical equipment such as transformers, switchboards, distribution boards, transfer switches and so forth.

- C. Securely support fixtures installed under this work from the building structure via ceiling wires. Ceiling wires installed by ceiling contractor.
- D. Support all junction boxes, pull boxes or other raceway terminating housings located above the suspended ceiling from the floor above, roof or penthouse floor structure to prevent sagging or swaying.
- E. SMACNA guidelines may be applied for suspended conduits and equipment. Prove the systems and details meet the requirements of CBC 1632A.6.
- F. Minimum support capacity: Not less than four times the ultimate weight of the object being supported from the building structure or anchored to the structural floor.
- G. Seismic Protection Criteria: Electrical equipment installations in any Seismic Risk Zone of the 2006 International Building Code Seismic Risk Map shall be protected from earthquakes. Protection criteria for these zones shall be a Horizontal Force Factor as prescribed by the CBC multiplied by the equipment weight considered passing through the machinery center of gravity in any horizontal direction.
 - 1. Unless vibration isolation is required to protect equipment against unacceptable structure transmitted noise and/or vibration, equipment shall be protected from earthquakes by rigid structurally sound attachment to the load supporting structure. The force factor and anchorage shall be determined by calculations performed by a registered California Structural engineer whether the isolators are present or not and shall be verified by the seismic restraint vendor.
 - 2. Vibration isolated equipment shall be protected by protected spring isolators or separate seismic restraint vendor. Seismic snubbers and protected spring isolators shall be seismic protection rated in three principal axes by independent laboratory testing or analysis by an independent licensed structural engineer.
 - 3. The Contractor shall be responsible for the design of his own seismic restraint systems. He shall supply to the Architect details of the forces exerted by his restraints, anchorages, and other points of attachment.
 - 4. Seismic protection, labor, materials and design shall be included in the Contract Sum.
- H. Contractor shall provide structural calculation and shop drawings for electrical equipment support. These drawing and calculations shall be prepared, sealed and signed by a Registered California Structural Engineer, and submitted for review and approval.
- I. Construction of all electrical gear, and equipment such as switchgear, switchboard, motor control center, panelboard, transformer and similar equipment shall meet seismic requirements per the CBC 2013 Section 1705A.12.4, Special Seismic Certification.

3.8 ALIGNMENT

- A. Install panels, cabinets and equipment level and plumb, parallel with structural building lines. Join switchgear, panels and electrical enclosures so that they fit neatly together without gaps, openings or distortion.
- B. Fit surface panels, devices and outlets with neat, appropriate trims, plates or covers, without over-hanging edges, protruding corners or raw edges, to leave a finished appearance.

3.9 CUTTING, PATCHING, EXCAVATING, AND CORE DRILLING

- A. Coordinate necessary cutting and patching for the electrical work in compliance with Division 01 - COORDINATION.
- B. Neatly patch and finish any surface damaged by this work to match adjacent construction surface conditions; for instance, repair surfaces where raceways pass through finished floors or walls. Clean and remove all dirt and debris. Perform this work to the satisfaction of the Architect.
- C. Where equipment installations or connections require the installation of an access panel, provide a properly sized and installed access panel similar to those used for mechanical equipment access. Access panels shall be provided and installed by the framer.
- D. Do not cut or break any steel or wood framing, concrete, masonry, or partitions, etc., without permission from the Architect or as shown on the Drawings.
- E. Cut, channel, chase and drill floors, walls, partitions and ceilings as necessary for the proper installation, support and anchorage of raceway, boxes, and other equipment.
 - 1. Repair any damage to the building, piping, equipment, or finish.
 - a. Perform repairs with materials matching the original, and install in accordance with appropriate sections of these Specifications.
- F. All cuts and penetrations of existing structural walls and floors that do not appear on the Structural Drawings must be x-rayed prior to beginning work. Assure that all conduit penetrations pass through the center of all rear "windows" or avoid structural members by a minimum of 12". All cuts that are not covered by detail on the Drawings must be pre-approved by the Structural Engineer prior to proceeding.
- G. All concrete work shall be in accordance with Division 03.

3.10 WATERPROOFING

- A. Avoid, if possible, penetrations of waterproof membranes.
- B. Where such penetration is required, perform it prior to waterproofing and in accordance with Architectural details.
- C. Where penetrations are not detailed, provide a detail of the penetrations for approval of the Architect.

3.11 COORDINATION OF WORK

- A. Coordinate with the requirements of Division 01 COORDINATION and Section 26 00 30 - MECHANICAL EQUIPMENT COORDINATION.
- B. Conduct work in a manner to cooperate with all other trades for proper installation of all items of equipment. Consult the Drawings of all other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members, mechanical and plumbing work. In general, the architectural drawings govern but resolve conflicts with the Architect prior to rough - in.

- C. Verify the physical dimension of each item of electrical equipment to fit the available space. Contractor is responsible for coordinating electrical equipment space requirements with the allotted space provisions, and access routes through the construction area.
- D. Coordinate rough-in and wiring requirements for all mechanical, kitchen and medical equipment with equipment supplier and installer. Make installation in accordance with rough-in and wiring diagrams provided for Contractors use.
- E. Coordinate all aspects of the electrical services with the appropriate serving utility.
- F. Coordinate underground work with other contractors working on the site. Perform coordination with contractors installing storm sewer, sanitary sewer, water and irrigation lines, to avoid conflicts. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.

3.12 PROTECTION OF WORK

- A. Coordinate with the requirements of Division 01 - PRODUCT OPTIONS AND SUBSTITUTIONS.
- B. Protect all electrical work and equipment against damage by other trades, weather conditions or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.
- C. Keep switchgear, transformers, panels, luminaires and all electrical equipment covered or closed to exclude dust, dirt and splashes of plaster, cement or paint and shall be free of all such contamination before acceptance. Keep enclosures and trims in new condition, free of rust, scratches and other finish defects. If damaged, properly refinish in a manner acceptable to the Architect.

3.13 ADJUSTING

- A. Coordinate with the requirements of Division 01 - QUALITY CONTROL.
- B. Voltage Check:
 1. At job completion, check voltage at several points of utilization for power equipment installed under this work. During voltage check, energize installed loads.
 2. Adjust transformers taps for acceptable voltage level; 118 to 122 volts for 120 volt nominal systems and proportionately equivalent for higher voltage systems. If proper voltage cannot be obtained, inform the owner's representative and the serving utility company.

3.14 CLEANING AND PAINTING

- A. Finish painting under Section 09 91 00. Including surface preparations, priming, and finish coating for electrical cabinets, exposed conduit, pull and junction boxes.
- B. Refinish Work supplied with final finish under this Division if damaged under this Division to satisfaction of Architect.

- C. After other Work is accomplished, panels (interiors and exteriors), fixtures, equipment and leave in satisfactory condition.

3.15 EQUIPMENT IDENTIFICATION

- A. Refer to Section 26 05 53 for equipment identification requirements.

3.16 COMMISSIONING AND TESTING

- A. Upon job completion, test systems and show that the equipment installed operates as designed and specified, free of faults and unintentional grounds. The system tests may be set up and done for coordination with construction phasing. Perform testing or system operational functions in the presence of the Architect or his representatives. Schedule work in advance and as directed by the Architect or his representatives.
- B. Provide a minimum of 1 journeyman electrician with required tools during testing or system commissioning work. Provide equipment factory representative for this work when needed.
- C. Provide testing and commissioning work for equipment and systems noted in Division 26 specifications and drawings, including but not limited to:
 - 1. Low voltage distribution system.
 - 2. Grounding system
 - 3. Emergency power system.
 - 4. Lighting system.
 - 5. Lighting control system.

3.17 PROJECT CLOSEOUT

- A. Coordinate with the requirements of Division 01- SUBSTANTIAL AND FINAL COMPLETION.
- B. Special tools or safety equipment: Provide one of each tool or piece of safety equipment required for proper operation and maintenance of equipment installed under this work. Coordinate equipment required with equipment manufacturer and O'Connor Facility Engineer.
- C. Keying: Provide two keys for each lock furnished under this work.

END OF SECTION

SECTION 26 00 80 TESTING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Test procedures specified in this Section are in addition to that specified in other Sections of Division 26.
- B. Provide the services of a recognized independent testing firm to perform testing work, including but not limited to:
 - 1. Unit substations, switchboards, and distribution boards.
 - 2. Grounding system.
 - 3. Circuit breakers 50 amperes and larger.
 - 4. Transformers, 75 kVA and larger.
 - 5. Electronic power monitors.
 - 6. Instruments and instrument transformers.
 - 7. Combination Motor Starters
 - 8. Thermographic survey.
- C. Coordinate functional testing of automatic transfer switches with manufacturer's representative and Section 26 36 00—TRANSFER SWITCHES requirements.

1.2 REFERENCES

- A. Perform inspections and tests in accordance with the following codes and standards:
 - 1. National Electrical Manufacturers Association - NEMA.
 - 2. American Society for Testing and Materials - ASTM.
 - 3. Institute of Electrical and Electronic Engineers - IEEE.
 - 4. International Electrical Testing Association - NETA Acceptance Testing Specifications -ATS-1 991
 - 5. American National Standards Institute - ANSI.
 - 6. State and local codes and ordinances.
 - 7. Insulated Cable Engineers Association - ICEA.
 - 8. Occupational Safety and Health Administration - OSHA.
 - 9. California Electrical Code (CEC) 2016 Edition
 - 10. California Building Code (CBC) 2016 Edition
 - 11. ANSI/NFPA 70B: Electrical Equipment Maintenance.
 - 12. NFPA 70E: Electrical Safety Requirements for Employee Workplaces.
 - 13. ANSI/NFPA 78.
 - 14. ANSI/NFPA 101.

- B. Division 26 specification sections and drawings are interrelated. Use Division 26, in its entirety, and accompanying electrical drawings for interpreting inspection and testing requirements.
- C. Use Manufacturers instruction manuals applicable to each particular apparatus for special inspection and testing requirements.

1.3 SUBMITTALS

- A. Comply with provisions of Division 01 - SUBMITTALS.
- B. Provide the following certified test report information, including but not limited to:
 - 1. Summary of job.
 - 2. Description of equipment tested.
 - 3. Description of test procedure.
 - 4. List of test equipment and calibration date.
 - 5. Test results.
 - 6. Conclusions and recommendations.
 - 7. Appendix, including all field test reports.
- C. Provide report certification by a licensed electrical engineer.
- D. Secure report and test documents together using index tabs and a 3 ring binder.
- E. Provide brief field report after completion of any test prior to leaving the site. Report may be typed or printed. List the equipment tested, describe any deficiencies found and recommended corrections. Leave report copies with the Inspector of Record (IOR) and General Contractor.

1.4 TESTING AGENCY QUALIFICATIONS

- A. Company that is a financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers and installers of equipment or systems evaluated by the testing firm.
- B. Member of the International Electrical Testing Association, specializing in the testing of equipment or apparatus specified in this Section with minimum 3 years experience.

1.5 DIVISION OF RESPONSIBILITY

- A. Routine work performed by the Contractor prior to and in addition to tests performed by the testing firm:
 - 1. Cleaning of equipment and apparatus.
 - 2. Insulation-resistance and continuity test.
 - 3. Rotation test.
 - 4. Equipment bolt torquing.
 - 5. Inspect for physical damage.
 - 6. Proper equipment connection and operation.

7. Coordinate exact motor overload requirements.
- B. The Contractor has the option to assign all or any portion of above listed routine work to the testing firm at his own expense.
- C. The Contractor shall provide suitable and stable source of electrical power to each test site as required by the testing firm.
- D. The Contractor shall notify the Inspector of Record (IOR) and the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
- E. The Owners Representative is responsible for reviewing the short-circuit analysis and coordination study prepared and certified by an independent testing or engineering firm or manufacturer as outlined by Section 26 00 10- BASIC ELECTRICAL REQUIREMENTS and section 26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.
- F. The testing firm shall notify the Owners Representative prior to commencement of any testing.
- G. Report any system, material, or workmanship which is found defective on the basis of acceptance tests to the Owners Representative in writing.
- H. The testing firm shall maintain a written record of all tests and, upon completion of project, assembles and certifies final test report.
- I. Safety and Precautions:
1. Safety practices include, but are not limited to, the following requirements:
 - a. Occupation Safety and Health Act.
 - b. Accident Prevention Manual for Industrial Operations, National Safety Council.
 - c. Applicable state and local safety operating procedures.
 - d. Owner's safety practices.
 - e. National Fire Protection Association - NFPA 70E.
 - f. American National Standards for Personnel Protection.
 2. Testing performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
 3. The testing firm shall provide a designated safety representative on the project to supervise the testing operations with respect to safety.
 4. The electrical contractor shall provide an arc flash study to determine the recommended Personnel Protective Gear suitable for this project and prior to testing. Arc flash study shall be submitted for review by owner's representative.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The testing agency shall provide all required test equipment.
- B. Care and Precautions:

1. Contractor is responsible for any damage to equipment or material due to improper test procedures or test apparatus handling. Replace or restore to original condition any damaged equipment or material.
2. Provide and use safety devices such as rubber gloves and blankets, protective screen, barriers and danger signs to adequately protect and warn all personnel in the vicinity of the tests.
3. Use test equipment that is calibrated and certified traceable to the National Bureau of Standards. Certification date: No later than 6 months prior to test for analog meters and 12 months for electronic meters.

PART 3 - EXECUTION

3.1 TESTING FIRMS

- A. Pacific Power Testing
- B. Apparatus Testing & Engineering
- C. OR pre-approved equal. Submit proposed testing firm along with qualifications to EEOR for approval.

3.2 APPLICATION

- A. General:
 1. Provide all materials, supplies, tools, equipment, labor, and services required to perform all tests as specified in this Section.
 2. Correct all deficiencies revealed by tests. Replace at contractors cost, all materials and equipment found faulty.
 3. The testing intent is to assure that all electrical equipment, both contractor and Owner supplied, is operational within industry and manufacturers tolerances and is installed in accordance with design specifications.
 4. The test and inspections determine the suitability for energization.
 5. Use the International Electrical Testing Association (NETA) guidelines for all testing procedure and acceptance test values of results.
 6. Complete all test prior to commissioning and final acceptance.
- B. Summary:
 1. Test all cable, equipment and systems listed above to assure proper installation, setting, connections, and functioning in accordance with the Drawings, Specifications, and the manufacturer's recommendations. It is the intent that field testing be extensive, and complete as specified, to provide positive assurance of totally correct installation and operation of equipment.
 2. Furnish all necessary test equipment to satisfactorily perform all tests specified herein.
 3. When conducting tests, comply with the following:
 - a. Notify the Owner and IOR at least 2 weeks prior to commencement of any testing.
 - b. Conduct all tests in the presence of the Owners Representative and IOR except when advised that his presence will not be necessary.

- c. Include all tests and inspections recommended by the equipment manufacturer whether required by these Specifications or not, unless specifically waived by the owner.
 - d. Maintain a written record of all tests showing date, personnel making test, equipment or material tested, tests performed, manufacturer and serial number of testing equipment and results.
4. Tests include, but are not limited to, the following:
- a. All Wiring: Free of shorts unintentional and grounds.
 - b. Molded case breakers 50 amperes and larger. Time and instantaneous tripping, physical condition, contact resistance, insulation resistance.
 - c. Grounding system: Ground resistance (impedance), ground integrity.
 - d. Motor Controls: Proper overload heater sizes.
 - e. Switchboards, panelboards, and similar circuit breaker equipment: Insulation resistance, physical condition.
 - f. Feeder Cables: Insulation resistance.
 - g. Motors: proper rotation and insulation resistance.
- C. Minimum Acceptable Test Results:
- 1. Ground System: The main ground electrode system resistance to ground no greater than 5 ohms.
 - 2. Electrical Apparatus and System Insulation Resistance:
 - a. Rating of equipment of 600 volts: Use 1000 volt D.C. test voltage. Minimum insulation resistances, 100 megohms.
 - 3. Wire and Cables Under 600 Volts:
 - a. Rating of cables of 600 volts maximum: Use 1000 volt D.C. test voltage. Minimum insulation resistance, 100 megohms.

3.3 TECHNICAL REQUIREMENTS

- A. Grounding Systems:
- 1. Tests include measurement of ground resistance at the following equipment and structures:
 - a. All power transformer frames and neutral grounds.
 - b. All secondary switchboards located within buildings.
 - c. Other miscellaneous grounds selected at random in a manner to be representative of the entire installation.
 - d. Ground system ground rods, including those in manholes.
 - e. Isolated instrumentation system.
 - 2. Use "3 probe - fall of potential" method ground tests made on system ground rods. All other ground tests may be measured to system ground by use of ground reference method.
 - 3. Verify that ground system installation is completed before performing testing work.
 - 4. Ground circuits showing more than 20 ohms resistance will be considered defective and repaired by the Contractor at his own expense.
- B. Switchboard Breakers:
- 1. Electrical Tests:
 - a. Megger test breaker. Voltage 1000V phase to phase, phase to ground with breaker closed, cross pole breaker open.
 - b. Check trip free operation.

- c. Test trip devices using the primary injection current method. Verify trip timing to manufacturer's specification values. Test values that fail to meet the NETA or manufacturer guidelines: Include equipment, device, test values and failure reason on the daily report submitted to the IOR and General Contractor.
- C. Digital or Analog Instruments:
- 1. Ammeter:
 - a. Check connections from current transformer.
 - b. Check ammeter function for proper operation. Test calibration at half and full scale. Also check calibration at cardinal points.
 - 2. Voltmeter:
 - a. Check connections from potential transformer.
 - b. Check voltmeter function for proper operation. Test calibration at full scale and at nominal system voltage. Also check calibration at cardinal points.
- D. Electronic Power Monitors:
- 1. Check connections to potential and current transformers.
 - 2. Verify operation of monitor parameters and compare read-out values to actual measured values.
- E. Instruments Transformers (Current and Potential Transformers):
- 1. Physically check polarity mark orientation on all CT's and PT's with 3 line diagrams and manufacturer's drawings.
 - 2. Where CT's are used for protective relaying, the following tests shall be performed:
 - a. Electrically check for correct polarity markings.
 - b. High current ratio test by injection of primary currents. Current readings shall be taken at relays, meters, and instrument test blocks to verify CT ratio with connected burden.
 - 3. Electrically check all PT polarity markings
 - 4. Verify that secondary circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3
- F. Ground Fault System:
- 1. Complete testing work before the initial energization of the service equipment.
 - 2. Determine the relay pickup current within the limits of the device tolerance by primary injection of current at the C.T. and effecting a main protective device trip operation.
 - 3. Determine the relay pickup by current injection at the sensor and operate the interrupting device.
 - 4. Test the relay timing function by current injection. Verify timing to manufacturer's specification values.
 - 5. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
 - 6. Test the system's neutral insulation resistance to ensure no shunt ground paths. Remove the neutral-ground disconnect like, neutral meggered clear and link replaced.
 - 7. Operate the monitor (test panel) to ensure proper indication and test operation sequence.
 - 8. Affix calibration labels to all equipment tested. Labels data: Test, engineer, firm name and relay trip date as calibrated (trip time and relay setting in amperes).

9. During construction, set relay pickups at minimum values. Set final ground fault system settings to the 'approved' coordination study values.
- G. Transformers - Dry-Type, larger than 45 KVA:
1. Visual and Mechanical Inspection:
 - a. Inspect for physical damage, proper installation, anchorage and grounding.
 - b. Verify proper auxiliary device operation such as fans, temperature indicators, etc.
 2. Electrical Tests:
 - a. Perform insulation resistance tests winding-to-winding and winding-to-ground
 - b. Perform turns ratio test between windings for all tap positions. On medium voltage transformers, perform turns ratio test at all high voltage winding tap positions.
 - c. On medium voltage transformers, perform a winding resistance test of each winding in the nominal tap position.
 - d. On medium voltage transformers, measure core insulation resistance at 500V DC if the core ground strap is removable.
- H. Thermographic Survey
1. Visual and Mechanical Inspection:
 - a. Perform thermographic survey when load is applied to the system.
 - b. Electrical Contractor to remove all necessary covers prior to thermographic inspection, using appropriate caution, safety devices, and personal protective equipment in accordance with NFPA 70E. Utilize infrared windows wherever installed.
 2. Provide a report including the following:
 - a. Description of equipment to be tested.
 - b. Discrepancies.
 - c. Temperature difference between the area of concern and the reference area.
 - d. Probable cause of temperature difference.
 - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - f. Identify load conditions at time of inspection.
 - g. Provide photographs and thermograms of the deficient area.
 - h. Recommended action.
 3. Test Parameters:
 - a. Inspect new distribution system with imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.
 - b. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - c. Thermographic surveys shall be performed during periods of maximum possible loading.

3.4 RETESTING

- A. Retest any equipment which does not pass initial tests, or where subsequent testing is required for acceptance as directed by the Owners Representative.

3.5 REPLACEMENT OF DEFECTIVE MATERIAL OR EQUIPMENT

- A. Repair or replace any material or equipment found defective or cannot pass the tests specified in this Section at no additional cost to the Owner.

- B. Complete correction of defective material or equipment and retesting within the Contract period.
- C. If the equipment or material cannot pass the second test, remove the defective equipment and replace it with equivalent equipment that meets the requirements of the Specifications. Such replacement at no additional cost to the Owner.
- D. Remove defective equipment or material from the site no later than 15 days from the date of notification by the Owner or his representative.

3.6 FIELD ADJUSTMENTS

- A. Testing firm responsible for final setting and adjustments on protective devices in accordance with values from the coordination study specified in Section 26 00 10— BASIC ELECTRICAL REQUIREMENTS and section 26 05 73 Overcurrent Protective Device Coordination Study and reviewed by the Owners Representative.

END OF SECTION

SECTION 26 05 13 MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes cables and related splices, terminations, and accessories for medium voltage electrical distribution systems.

1.3 REFERENCES

- A. NETA ATS Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems, 2013 edition
- B. California Electrical Code (CEC) 2016 Edition
- C. California Building Code (CBC) 2016 Edition

1.4 SUBMITTALS

- A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each cable and accessory type, signed by manufacturers.
- D. Source quality-control test reports.
- E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to the EEOR
- B. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C2 2007 and CEC 2016.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cables:
 - a. Okonite Company.
 - b. Southwire Company.
 - 2. Cable Splicing and Terminating Products and Accessories:
 - a. Raychem
 - b. 3M; Electrical Products Division.
 - c. Elastimold

2.2 CABLES

- A. Cable Type: MV105.
- B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682.
- C. Conductor: Annealed uncoated copper compact stranded per ASTM B-496
- D. Conductor Stranding: Compact round, concentric lay, Class B.
- E. Strand Screen: Extruding semiconducting EPR strand screen. Meets or exceeds electrical requirements of ICEA S-93-639/NEMA WC74, AEIC CS8 and UL 1072.
- F. Conductor Insulation: Ethylene Propylene Rubber (EPR). Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8 and UL 1072. Insulation shall contain no polyethylene.
 - 1. Voltage Rating: 15 kV.
 - 2. Insulation Thickness: 220mil, 133 percent insulation level
- G. Insulation Screen: Extruded semiconducting EPR insulation screen.
- H. Shielding: 5ml bare Copper tape, helically applied over semiconducting insulation shield.
- I. Cable Jacket: Sunlight-resistant PVC.

2.3 SPLICE KITS

- A. Connectors and Splice Kits: Comply with IEEE 404 Standard for Extruded and Laminated Dielectric Shielded Cable Joints; type as recommended by cable or splicing kit manufacturer for the application.
- B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - 1. Cold or Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat or cold shrink jacket.

2.4 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48: Test Procedures and Requirements for Alternating-Current Cable Terminations. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
 2. Class 1 Terminations: Heat-shrink type with heat -shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield
 4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
 5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
 6. Class 3 Terminations: Kit with stress cone and compression-type connector.
- B. Nonshielded-Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

2.5 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386: Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V, with disconnecting. single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
- C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

F. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.

2.6 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant. PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket.
- C. Glass-Cloth Tape: Pressure-sensitive adhesive type. 1/2 inch wide.

2.7 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to Insulated Cable Engineers Association (ICEA) S-97-682 before shipping.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576, 2000: recommended practice for installation, termination, and testing of insulated power cable.
- B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
- C. Submit pulling tension and sidewall pressure calculations for all medium voltage cables installed in ductbanks and conduit showing compliance with all manufacturers recommended installation guidelines.
- D. In manholes, handholds, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- E. Install cable splices as indicated and where needed for pulling tension specifications.
- F. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.

- G. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc proofing tape manufacturer's written instructions, apply arc proofing as follows:
 - 1. Clean cable sheath.
 - 2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
 - 3. Smooth surface contours with electrical insulation putty.
 - 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 - 5. Band arc-proofing tape with 1-inch- wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.
- H. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- I. Identify cables according to Section 26 05 53 "Identification for Electrical Systems."
- J. Equipment grounding conductor: Provide green insulated 600V, THWN equipment grounding conductor in each conduit with medium voltage conductors. Bond to subsurface electrical equipment, manhole ground bus or rods, and associated non-current carrying metallic enclosures. Provide equipment grounding at all non-current carrying equipment and components that could become energized.
 - 1. Do not splice grounding conductor in manholes and vaults using the ground bus or ring. Make a straight splice with a tap to the manhole ground bus.
 - 2. Make grounding connections by exothermic welding or by copper compression connectors. Cable shield grounding connections may be made with copper split-bolt connectors.
 - 3. Provide grounding bushings and bond all metallic conduit.

3.2 TESTING AND FIELD QUALITY CONTROL

- A. Testing: Engage a qualified independent testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements to include but not limited to the following tests stated in NETA ATS:
 - 3. **Testing Equipment:** Testing equipment and devices used in performing the required tests shall have a calibration sticker affixed to each device stating the date when calibrated, date due for recalibration, and the signature of the individual who did the calibration. In addition to the sticker, a certificate shall accompany the testing equipment stating the standards to which the device was calibrated, the name of the calibrating agency, the name and signature of the calibrating individual, and the brand name and serial number of the device calibrated.

4. **Distribution Conductors 600 Volt Class:**

- a. All 600 volt class conductors #8AWG and larger shall be tested to verify that no short circuits or accidental grounds exist. Make the tests shall be made using an instrument which applies a voltage of approximately 1000 volts to provide a direct reading in resistance (Megger).

5. **Medium voltage Conductors:**

- a. All 15kv rated cables shall be given VLF (Dissipation Factor) tests after installation. Perform all tests in the presence of the Project Manager's representatives. Perform a VLF withstand test on all new medium voltage cable per IEEE 400.2 specifications
- b. Testing to be completed on new cables only.
- c. If any primary cable fails, or tests, in opinion of the testing agency and EEOR, show unacceptable cable defects all cables in that conduit between the nearest pulling points on each side of the failure shall be withdrawn. If, in the opinion of the testing agency and EEOR, other cables that may have been installed in the same duct are not damaged, they may be re-installed, but the failed cable shall be replaced with new cable without additional charge.
- d. After replacement of the faulty cable, and any other damaged cables, all cables of the circuit in that conduit shall be retested. If cable fails again, or if tests, in the opinion of the Project Manager, show unacceptable cable defects, all cables shall be replaced without charge and this procedure shall be repeated until tests prove satisfactory

B. **Test Reports:** Submit two copies of the test result reports to the Project Manager for each cable tested.

C. Refer to 26 00 80 – TESTING REQUIREMENTS for system testing.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 V AND LESS)

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. General building wire.
 - 2. Armored cable (Type HCF-MC^{AP}) shall not be used except where pre-approved by the EEOR.
 - 3. Flexible cord/cable (Type "S")
 - 4. RHW Two-Hour Fire Rated Cable Assembly
 - 5. Pull cord.
 - 6. Wire connectors and connections.

- B. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
 - 1. Division 01 for recycling requirements.
 - 2. Division 01 for dust and pollutant control requirements.
 - 3. Division 01 for VOC limits, recycled content, regional materials, and other sustainable design requirements.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified.
 - 1. UL-83, UL-44 - Thermoplastic-Insulated Wire and Cables.
 - 2. UL-4 - Armored Cable.
 - 3. UL-486A - Copper Connectors and Lugs
 - 4. UL-486BC - Aluminum Connectors and Lugs
 - 5. California Electrical Code (CEC) 2016 Edition
 - 6. California Building Code (CBC) 2016 Edition

1.3 SUBMITTALS

- A. Submit under provisions of Division 01 SUBMITTALS.

- B. Product Data: Product data for each conductor type on:
 - 1. Insulation
 - 2. Conductor material and dimensions

- C. Test Reports: Indicate procedures and values obtained.
- D. Design Data: Indicate voltage drop and capacity calculations for aluminum conductors for conductors substituted for copper conductors.
- E. Manufacturers Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.4 QUALITY ASSURANCE

- A. Provide materials that are new and unused.
- B. Manufacturer: Company specializing in manufacturing products specified in this Section with 3 years experience.
- C. No aluminum cable.
- D. The Contractor shall provide a "Megger" test report from the Testing Agency to the Owner's Representative for approval of the Work.

1.5 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on the Drawings.
- B. Conductor sizes are based on copper.
- C. Wire and cable routing shown on the Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
- D. When wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.6 COORDINATION

- A. Coordinate Work under provisions of Division 01.
- B. Determine required separation between cable and other work.
- C. Determine cable routing to avoid interference with other work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Marking: Insulation type, voltage rating, size and listing label shall be printed with permanent markings repeating along entire length of conductor.

- B. Provide all new wire and cable, manufactured within 12 months of delivery to site and continuously stored where protected from heat and weather.
- C. Conductor packaging and reels: Plainly marked or tagged with Manufacturers name, AWG, size, voltage rating, insulation type, agency listing and date of manufacture.

2.2 BUILDING WIRE AND CABLE

- A. Manufacturers: Alcan, General Cable, Kerite, Okonite, CME, Aetna, AIW, Southwire, Rome, Encore, AFC or equal
- B. Description: Single conductor insulated wire, UL listed for 600 volts insulation.
- C. Feeders: Copper Type XHHW or dual rated THWN/THHN.
- D. Branch Circuits: Lighting and Power
 - 1. #12 AWG minimum, stranded copper wire type THHN, THW or dual rated THHN/THWN, THHW (THHN for dry location only).
 - 2. #10 AWG and larger, stranded copper type THW or dual rated THHN/THHW
- E. For conductors installed in exposed conduit outside of Buildings, in exposed conduit in tunnel and conduit within or just under roofing material, provide type THWN or XHHW.
- F. Control Circuits: Use 600 volts U.L. type THHN/THWN or THWN conductors except where subject to abnormally high temperatures such as on or near boilers. Under these conditions, use UL type RHW-2.
- G. Wiring through fluorescent fixtures in continuous rows shall be type THHN.
- H. Color Coding:
 - 1. All power conductors identified as to phase and voltage by means of color impregnated insulation, as follows:

Voltage	ØA	ØB	ØC	Neutral	Ground	Isolated Ground
120/208V	Black	Red	Blue	White	Green	Green yellow tracer
277/480V	Brown	Orange	Yellow	Gray	Green	
 - 2. Switch Legs: Use same branch circuit phase color-coding except with white stripe.
 - 3. Switch Traveler: Purple with white stripe for 277 V. Purple with black stripe for 120 V.
- I. All conductors shall be color insulated.

2.3 ARMORED CABLE (MC) (SOUTHWIRE TYPE HCF-MC^{AP}) (where approved by the EEOR)

- A. Manufacturers: AFC, Alfex, Southwire or equal
- B. Description: ANSI/NFPA 70, Type MC. Approved for Health Care Facility use - CEC Article 517. Manufactured in accordance to CEC Article 333. Southwire Type HCF-MC^{AP} or equal.

- C. Conductor: Copper
- D. Insulation Voltage Rating: 600 volts.
- E. Insulation Temperature Rating: 90 degrees C.
- F. Insulation Material: Thermoplastic
- G. Armor Material: Steel
- H. Armor Design: Interlocked metal tape, corrugated tube or smooth tube.
- I. Number of conductors: Provide cable having a maximum of 7 conductors; 6 current carrying conductors, 1 ground conductor and 1 bare jacket bond strip or bare copper conductor.
- J. Ground: Internal insulated green copper conductor; 16 AWG uninsulated aluminum jacket bonding strip.

2.4 FLEXIBLE CORDS AND CABLE (TYPE SO)

- A. Provide Type 3 flexible cords and cables manufactured in accordance with CEC Article 400.
- B. Composed of two or more conductors and a full size green insulated ground wire with an outer jacket of rubber or neoprene.
- C. Equip flexible cords and cables with wire mesh strain relief grips either as an integral component of the connector or as an independently supported unit.
- D. Suspended flexible cords and cables using safety spring(s) unless otherwise noted on the Drawings.

2.5 PULL CORD

- A. Empty branch circuit or system conduits: Provide mildew resistant polypropylene line, minimum 210 pound tensile strength. Greenlee Poly-Line or equal.
- B. Empty feeder conduits or ducts: Provide mildew resistant polypropylene rope, minimum 1/4 inch diameter. Durlaine or equal.

2.6 MULTI-CONDUCTOR CONTROL CABLE

- A. Manufacturers: Alpha, Belden, or equal.
- B. Description: Multi-conductor insulated cable with color-coded PVC insulation over each conductor and an overall PVC jacket.
 - 1. Alternate material: PVC-free jacket.
- C. Conductor: Copper, stranded.

- D. Insulation Voltage Rating: 600V.
- E. Temperature Rating: -20 degrees C to +80 degrees C.
- F. Agency Certification: UL recognized, passes VW-1 flame test.

2.7 WIRING CONNECTORS

- A. Split Bolt Connectors:
 1. Burndy, "Servit" K series.
 2. Thomas & Betts "Locktite" T series.
 3. Or equal.
- B. Solderless Pressure Connectors:
 1. Burndy, "Qiklink" or "Qiklug" Q2 series.
 2. Thomas & Betts "Locktite" 32000 series.
 3. Or equal.
- C. Spring Wire Connectors:
 1. Ideal "Wingnut"
 2. WAGO's may be used in light fixtures or as specifically approved by the EEOR.
 3. Ideal twister
 4. Self-stripping pigtail and connectors are not permitted.
 5. Or equal.
- D. Compression Connectors:
 1. Burndy "Hylink" YS Long Barrel Series
 2. Thomas & Betts "Color-Keyed" 54500 Series
 3. Or equal.
- E. Compression Type Terminating Lugs:
 1. Copper wire and cable connections. Use long barrel type, tin plated copper/aluminum compression lugs having color-keyed tool die index marking. Provide 1-hole lugs for 8 AWG through 4/0 AWG. Provide 2-hole lugs for 1/0 AWG and larger. 2 hole compression lugs to be used in Metal Clad Switchgear at secondary switchboards, 1 hole compression lugs to be used at incoming Metal Enclosed switchgear. Use minimum of three crimps per lug or as recommended by the manufacturer. T & B Series 54800/54900 or equivalent.
 2. Notch or single point type crimping is not permitted.
 3. Mechanical type lugs are acceptable for all other lugs. Where mechanical lugs or connectors are used, access to the lug or connector shall be maintained to allow periodic tightening.
- F. Terminal Strips
 1. Provide box type rail mounted terminal block system. Furnish required quantity plus 25 percent spare. Install using continuous rows method in terminal cabinets. Provide ampere ratings as required. T & S Series HR, GR, or equivalent
 2. Identify all terminals with same numbering sequence being used for a particular system. Use marking strips to identify terminals.

G. Crimp Type Connectors:

1. Provide insulated fork or ring crimp terminals with tinned electrolytic copper-brazed barrel, funnel wire entry and insulation support. T & B RA Series or equivalent
2. Fasten crimp type connectors or terminals using a crimping tool recommended by the connector manufacturer.
3. Provide insulated overlap splices with tinned seamless electrolytic copper barrel with funnel wire entry and insulation support. T & B Series R or equivalent.
4. Provide insulated butt splices with tinned seamless electrolytic copper barrel with center stop, funnel wire entry and insulation support. T & B Series R or equivalent.

H. Cable Ties: Provide harnessing and point-to-point wire bundling using nylon cable ties, T & B Series TY, Panduit Pan-Rap or equivalent. Install ties using tool supplied or recommended by the manufacturer of ties.

I. Wire Lubricating Compound

1. UL listed for the wire insulation and conduit type. "Polywater J", Aquagel, yellow 77 or equivalent.
2. Use on wire for isolated type electrical power systems is not permitted.
3. No oil, grease, graphite, or similar substances may be used for pulling conductors in raceways.
4. Pulling of size #1/0 or larger conductors shall be done with an approved cable pull machine. Other methods; e.g. using vehicles, and block and tackle to install conductors shall not be acceptable.

J. Bolt Termination Hardware

1. Bolts: Plated, medium carbon steel heat treated, quenched and tempered conforming to ASTM A-325 or SAE grade 5; or silicon bronze alloy ASTM B-9954 Type B.
2. Nuts: Heavy semi-finished hexagon, conforming to ANSI Bi 8.2.2, threads to be unified coarse series (UNC), class 2B steel or silicon bronze alloy.
3. Flat washers: Steel or silicon bronze, Type A plain standard wide series, conforming to ANSI B27.2. SAE or narrow series are not permitted.
4. Conical spring washers: Hardened steel, cadmium plated or silicon bronze.
5. Maximum current capacity for bolt sizes:
 - a. 1/4" bolt - 125 amps
 - b. 5/16" bolt - 175 amps
 - c. 3/8" bolt - 225 amps
 - d. 1/2" bolt - 300 amps
 - e. 5/8" bolt - 375 amps
 - f. 3/4" bolt - 450 amps

2.8 INSULATION

A. Insulating Tape (600 volts and below):

1. Black, ultraviolet proof, self-extinguishing, 7 mil thick vinyl general purpose electrical type. Suitable for temperature from minus 18°C to 105°C. 3M "Scotch" #33 Plus or equal.

B. Cold-Shrink Tubing:

1. Raychem.

2. 3M
 3. Cold Shrink
 4. Or equal.
- C. Insulating Compound (600 Volts and Below):
1. Vinyl Mastic: Self-fusing, rubber-based insulating compound, laminated to an all-weather grade vinyl (PVC) backing. 3M/Scotch 2200 Series or equal.
 - a. Alternate material: PVC-free jacket.
 2. Insulation Putty: Electrical grade, rubber-based, elastic-type puffy in tape form. 3M Scotchfil or equal.
- D. Insulating Resin:
1. Use two part liquid epoxy resin with resin and catalyst in premeasured, sealed mixing pouch. Scotchcast 4 or equal.
 2. Use with thermal and dielectric properties equal to the insulating properties of the cables immersed in the resin.

2.9 ACCESSORIES

- A. Vertical Cable Supports:
1. O-Z/Gedney, Type "M"
 2. Adalet, "SVM" series
 3. Or equal.
- B. Conductor Ties:
1. Panduit, "Pan-ty"
 2. Thomas & Betts, "Ty-rap"
 3. Or equal.
- C. Conductor Sealant:
1. Dow-Corning, #795 silicone
 2. General Electric, #SCS1000 silicone
 3. Or equal.
- D. Adhesives and sealants shall comply with VOC limits in Division 1.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

- A. Install products in accordance with manufacturer's instructions.
- B. Concealed dry interior locations; normal power systems: Use Type THHN wire in conduit. Use Type XHHW or dual rated THHN/THWN insulation for feeders. Use stranded conductors for control circuits, connection to motors and vibrating equipment.

- C. Use conductor not smaller than 12 AWG for power and lighting circuits.
- D. Use conductor not smaller than 16 AWG for control circuits.
- E. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- F. Minimum conductor size for 20 ampere power and lighting branch circuits:
 - 1. Use 10 AWG conductors for 120 volt branch circuits longer than 75 feet to first outlet.
 - 2. Use 10 AWG conductors for 277 volt branch circuits longer than 200 feet to first outlet.
- G. Provide 10 AWG pig tails on all 20A and 30A wiring devices served by 8 AWG conductors and larger.
- H. Splice cables and wires only in outlet boxes, junction boxes, pull boxes, manholes, or handholes. When more than one neutral is present, group and bundle each neutral with its associated phase conductors.
- I. Install cable supports for all vertical feeders in accordance with the CEC.
- J. Panelboards, cabinets, wireways, switches, and equipment assemblies. Neatly form, train, and tie the cables. Use nylon ties for securing cable/wire bundles.
- K. Seal cable or wire, entering a building horizontally from underground or exiting walk-in cold box or freezer, using nonhardening approved compound, duct seal or equivalent. Seal at nearest box or panelboard raceway termination.
- L. Terminate stranded wire using fittings, lugs or devices listed for the application. Do not terminate stranded wire by wrapping it around a screw or bolt.
- M. Flexible cords and cables supplied as part of a premanufactured fixture or unit assembly: Install according to manufacturers published installation instructions.
- N. Use connectors with ampacity and temperature ratings equal to or greater than the wires that are being terminated.
- O. Exposed dry interior locations: Use Type THHN insulation for branch circuit wiring. Use Type XHHW or dual rated THHN/THWN insulation for feeders.
- P. Wet or damp locations: Use Type XHHW insulation for feeder and branch circuit wiring.
- Q. Use Type RHH or THHN insulation for wire installed in fixture channels.
- R. Parallel feeders: Install phase conductors and neutral conductors so that they are equal in length and identical in all ways.
- S. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors; conductors larger than 10 AWG, bundle in individual circuits. Make terminations so there is no bare conductor visible at the terminal.
- T. Where circuits require a neutral conductor, provide a dedicated neutral conductor for each circuit.

3.2 WIRING INSTALLATION IN RACEWAYS

- A. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- B. Pull all conductors into a raceway at the same time. Exercise care in pulling conductors so that insulation is not damaged.
- C. Use UL listed, non-petroleum base and insulating type pulling compound as needed.
- D. Completely mandrel all underground or concrete encased conduits prior to installing conductors.
- E. Completely and thoroughly swab underground raceway system before installing conductors.
- F. Do not use block and tackle, power driven winch or other mechanical means for pulling conductors smaller than 2 AWG.
- G. Wire Pulling:
 - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
 - 2. Use rope made of nonmetallic material for pulling feeders.
 - 3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors.
 - 4. Pull in together multiple conductors or cables in a single conduit.
 - 5. Use wire-pulling compound as lubricant for installing wires and cables in raceways. Use of oil, grease, graphite, or similar substances is not permitted.
- H. Install and test all cables in accordance with manufacturer's instructions and warranty.

3.3 INSTALLATION IN MANHOLES

- A. Install and support cables in manhole on Heavy Duty non metallic racking with porcelain or equivalent insulators, unless otherwise noted. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter or as recommended by the cable manufacturer.

3.4 CABLE INSTALLATION

- A. Where approved by the EEOR install HCF-MC^{AP} cable in accordance with manufacturer's instructions and in accordance with CEC Article 333. Follow manufacturer's instructions when connecting the cable to fittings and boxes. Secure connectors to the cable, but not overtightened. Firmly attach connector to the metal boxes.
- B. Support cables every 4.5 feet and within 12 inches of box or fitting using separate metal strap or spring metal clip for each cable. Do not bundle cables together.
- C. Do not support cables from raceways or mechanical piping.
- D. Do not rest cables on ceiling tiles or allow contact with mechanical piping systems.

- E. Cable connection to light fixtures: Acceptable to attach cable to fixture support wire using spring metal clip.
- F. Use UL approved cable connectors.
- G. Use cable having color code conductors.
- H. Provide separate sleeves and/or fire barriers for cable fire wall penetration, unless cable is UL listed for the application.
- I. HCF-MC^{AP} cable is not permitted for homerun use. Extend cable from junction/wireway box having branch circuits for the immediate area. Use conduit for routing branch circuit conductors from junction or wireway box to the panelboard.
- J. Use steel insulated throat cable connectors. OZ Gedney AMC Series or equivalent. Die cast or pressure cast fittings are not permitted.
- K. Provide ¼ inch threaded or solid rod, or ceiling wire above ceiling spaces for cable support, 4' on center. Use spring metal clip for cable attachment to rod.

3.5 WIRE SPLICES, JOINTS, AND TERMINATION

- A. Join and terminate wire, conductors, and cables in accordance with UL 486A, B, C, CEC and manufacturer's instructions.
- B. Thoroughly clean wires before installing lugs and connectors.
- C. Make splices, taps and terminations to carry full ampacity of conductors, without noticeable temperature rise.
- D. Make splices and termination mechanically and electrically secure.
- E. Where determined that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost.
- F. Terminate wires in terminal cabinets, relay and contactor panels using terminal strip connectors.
- G. Bundle spare conductors using nylon ties. Leave sufficient length to terminate anywhere in the panel or cabinet.
- H. Use nylon cable ties for bundling and securing wire and cable as required to maintain harnessing.
- I. Encapsulate below grade splices at outlet, pull and junction boxes using specified insulating resin kits. Make all splices watertight for exterior equipment and equipment in pump rooms.
- J. Make up all splices and taps in accessible junction or outlet boxes with specified connectors. Use same color pigtails and wire tap as the feed conductor. Form conductor prior to cutting. Provide at least 6 inches of tail and neatly packed in box after splice is made up. P&S factory pig tails are acceptable to use for receptacles.
- K. 8 AWG and smaller conductor connections:

1. Connectors: Solderless, screw on, reusable spring pressure cable type, 600 volt, 105 degree C, with integral insulation, approved for copper conductors.
 2. The integral insulator shall completely cover the stripped wires.
 3. The number, size, and combination of conductors, as listed on the manufacturers packaging shall be strictly complied with.
- L. 6 AWG and larger conductor connections:
1. Join or tap two conductors using compression (hi-press) taps specified. Cover using cold shrink insulation. Where more than two conductors are joined use a terminal block or Polaris type termination. Where terminating conductors in a motor connection use a split bolt connector wrapped with one layer of Scotch 2520 cambric tape, followed by two layers of Scotch 130C rubber splice tape and followed by two layers of Scotch 33 vinyl electric tape.
 2. Terminate conductors from size 6 AWG to 750 MCM copper using mechanical compression lugs in accordance with manufacturer's instructions.
 3. Cable sizes 250 MCM and larger: Use not less than two clamping elements or compression indents per wire for connectors.
 4. Aluminum conductors: Join conductors using compression splice barrels or bolted compression lugs. Terminate conductors using compression lugs. Apply number of compression indents as directed by the manufacturer instructions.
 5. Insulate splices and joints with materials approved for the particular use, location, voltage and temperature. Insulate with not less and that of the conductor level that is being joined.
 6. Use hydraulic crimping tool for making compression indents. Burndy Series Y35 Hypress or equivalent.
 7. Apply oxide inhibiting compound to conductors before joining, installing compression lugs or making aluminum terminations.
- M. Termination Hardware Assemblies:
1. AL/CU lugs connected to aluminum plated or copper bus: Secured using a steel bolt, flat washer (two per bolt), lock washer, and nut.
 2. Copper lugs connected to copper bus: Secured using steel bolt, flat washer (two per bolt), lock washer, and nut.
 3. Torque bolted assemblies using the manufacturer's recommendations. In the absence of such recommendations, use torque values listed in UL 486 Standards.
 4. Apply silicon spray or other suitable lubricant before torquing bolts. Clean bolt surface after torquing. Mark torqued bolt heads using red or pink lacquer paint Torque Seal or equivalent.

3.6 TYPE MI CABLE INSTALLATION

- A. Install MI cable in accordance with manufacturer instructions and in accordance with CEC Article 330.
- B. Use fitting recommended by the manufacturer.
- C. Support cable every 6 feet using straps or hangers.
- D. Seal cable after stripping to prevent moisture from entering the insulation.

3.7 IDENTIFICATION

- A. Refer to Section 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS for additional requirements.
- B. Securely tag all branch circuits, noting the purpose of each. Mark conductors with specified vinyl wrap-around markers. Where more than two conductors run through a single outlet, mark each conductor with the corresponding circuit number.
- C. All conductors shall be color insulated.
- D. Provide terminal strips with write on marking strips.
- E. In manholes, Christy boxes and handholes, provide phenolic tags. Show the cable type and voltage rating. Attach the tags to the cables with slip-free plastic cable lacing units.

3.8 HOMERUNS

- A. Permissible to combine up to 4#10 current carrying conductors for an individual homerun in ½ inch conduit. Permissible to combine up to 8#10 current carrying conductors for an individual homerun in ¾ inch conduit. Permissible to combine up 14 # 10 current carrying conductors of an individual homerun in 1 inch conduit. Permissible to combine up to 20#10 current carrying conductors for an individual homerun in 1-1/4 inch conduit.
- B. Permissible to combine up to nine current carrying conductors for circuits feeding mechanical equipment as long as the conductor has the same ampacity.
- C. Homeruns containing more current carrying conductors than not in paragraph 3.8A and 3.8B are not permitted without approval of electrical engineer of record and derating per CEC article 310.
- D. Adjust branch circuit conductor ampacity in accordance to CEC article 310. Provide higher ampacity conductor sizes as needed.

3.9 VOLTAGE DROP

- A. Maximum length of cable for each department shall not exceed the length provided in the following table. Refer to the table in 3.9B for specific maximum lengths unless specifically noted on drawings.
- B. Where required conductor length not to exceed the following distance unless specifically noted on drawings, or by vendor specific requirements.

END OF SECTION

Voltage Drop				
Single Phase, copper conductor, conduit installation				
VOLTAGE	FEEDER SIZE	DISTANCE	AMPACITY	VD%
120V	#12	45ft	20A	3.00%
220V	#12	90ft	20A	3.00%
277V	#12	115ft	20A	3.00%
120V	#10	80ft	20A	3.00%
220V	#10	140ft	20A	3.00%
277V	#10	190ft	20A	3.00%
120V	#8	120ft	20A	3.00%
220V	#8	220ft	20A	3.00%
277V	#8	280ft	20A	3.00%
120V	#6	190 ft	20A	3.00%
220V	#6	360 ft	20A	3.00%
277V	#6	440 ft	20A	3.00%

Voltage Drop				
Three Phase, copper conductor, conduit installation				
VOLTAGE	FEEDER SIZE	DISTANCE	AMPACITY	VD%
208V	#12	100ft	20A	3.00%
480V	#12	225ft	20A	3.00%
208V	#10	160ft	20A	3.00%
480V	#10	380ft	20A	3.00%
208V	#8	240ft	20A	3.00%
480V	#8	580ft	20A	3.00%
208V	#6	400 ft	20A	3.00%
480V	#6	920 ft	20A	3.00%

3.10 TESTING

- A. Refer to Section 26 00 80 - TESTING REQUIREMENTS, for system testing requirements.

- B. "Megger" tests shall be taken on all feeder conductors and on all conductors for motors over 15 HP. Tests shall be made prior to connection of equipment. Conductors tested to be below manufacturers' standard, shall be replaced at the Contractors expense.

3.11 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Section 26 05 53.
- B. At each junction or pullbox, identify each conductor with its circuit number or other designation indicated on Drawings.

3.12 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Section 26 00 80.
- B. Inspect wire and cable for physical damage and proper connection.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturers recommended values.
- D. Verify continuity of each branch circuit conductor.

END OF SECTION

SECTION 26 05 26 GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Power system grounding.
 - 2. Electrical equipment grounding and bonding.
 - 3. Miscellaneous bonding and grounding.

- B. System Description
 - 1. The entire electrical installation (non-current carrying metal parts), including but not limited to, metallic conduits and raceways, cable trays, junction and pull boxes, enclosures, fixtures, service equipment, distribution boards and panels, transformers, grounding type receptacles, switches, motor frames, cabinets and equipment shall be completely and effectively grounded in accordance with all code requirements, whether or not such connections are specifically shown or specified.
 - 2. Resistance
 - a. Resistance from the farthest panelboard, switchboard, and etc. ground bus through the ground electrode to earth shall not exceed 20 OHMS.
 - 3. Ground each separately derived system neutral as described herein except as otherwise shown or specified.
 - 4. Electrical continuity to ground metal raceways and enclosures, isolated from the equipment ground by use of non-metallic conduit or fittings, shall be provided by a green insulated grounding conductor of approved size within each raceway connected to the isolated metallic raceways or enclosures at each end.

- C. Furnish Products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.2 RELATED SECTIONS

- A. Section 03 21 00 - Concrete Reinforcement.
- B. Section 03 31 00 - Cast-In-Place Concrete.
- C. Division 01 for recycling requirements.
- D. Division 01 for dust and pollutant control requirements.
- E. Division 01 for VOC limits, recycled content, regional materials, and other sustainable design requirements.

1.3 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. NFPA 99 - Health Care Facilities.
 - 2. IEEE Standard 80 - Guide for Safety in AC Substation Grounding.
 - 3. IEEE Standard 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Parts 1 & 2).
 - 4. IEEE Standard 141 - Recommended Practice for Electrical Power Distribution for Industrial Plants.
 - 5. IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 6. IEEE Standard 110 - Recommended Practice for Powering and Grounding Electronic Equipment.
 - 7. UL 467 - Electrical Grounding and Bonding Equipment.
 - 8. UL 869 - Electrical Service Equipment.
 - 9. California Electrical Code (CEC) 2016 Edition
 - 10. California Building Code (CBC) 2016 Edition

1.4 SUBMITTALS

- A. Submit under provisions of Sections 26 00 10 and Division 01 – SUBMITTALS.
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit manufacturer's installation instructions.
 - 4. Bill of materials, listing all components
 - 5. Field test reports
- B. Record Drawings
 - 1. Record drawings shall indicate the location of all ground rods and supplementary grounding electrodes connected to the grounding system.
 - 2. The location of each ground rod, ground-rod assembly, and other grounding electrodes shall be identified by letter in alphabetical order and keyed to the record of ground-resistance tests.
- C. Typewritten records of measured resistance values shall be submitted for review and included with the operation and maintenance manual furnished to the Owner at the time of project closeout.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum ten years documented experience.

PART 2 - PRODUCTS

2.1 ROD ELECTRODE

- A. Manufacturers:
 - 1. Blackburn
 - 2. Erico
 - 3. Or equal.
- B. Material: Copper-clad steel with heavy uniform copper coating.
- C. Diameter: 3/4-inch.
- D. Length: 10 feet

2.2 MECHANICAL CONNECTORS

- A. Manufacturers:
 - 1. Burndy
 - 2. OZ/Gedney
 - 3. Thomas & Betts/Blackburn
 - 4. 3M
 - 5. IlSCO
 - 6. Or equal.
- B. Material: Bronze.
- C. For use only above ground.
- D. Water pipe connectors: OZ/Gedney G-200B series or equal.
- E. Bonding Jumpers: OZ/Gedney BJ series or equal.
- F. Ground rod connection: U-bolt clamps by T&B/Blackburn "GUV" or Burndy "GAR" series or equal.

2.3 COMPRESSION CONNECTIONS

- A. Manufacturers:
 - 1. Thomas & Betts compression system.
 - 2. Burndy "Hyground" compression system.
 - 3. Or equal.
- B. Material: Copper.

2.4 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. Cadweld
 - 2. Thermoweld
 - 3. Or equal.

2.5 WIRE

- A. Material: Stranded copper.
- B. Grounding Electrode conductor: Size to meet CEC requirements.
- C. Equipment grounding conductor: Use green THW / THWN insulated copper wire. For conductors that are not commercially available with green insulation; identify using green plastic tape in accordance with Section 26 05 53 — ELECTRICAL IDENTIFICATION and CEC.

2.6 GROUNDING WELL COMPONENTS

- A. Wells/Yard boxes: Boxes shall be precast concrete and shall be approximately 14" wide, 19" long and 12" deep (outside dimensions), or larger, if necessary to obtain the required clearances.
- B. Well Cover: shall be bolt down, checkered, cast iron covers with a cast iron frame cast into the box. Cover shall be labeled "GROUND".

2.7 INSULATED GROUNDING BUSHINGS

- A. Plated malleable iron body with molded plastic insulating throat (150°C rated) and lay-in grounding lug. Manufactured by OZ/Gedney "BLG" series, Thomas & Betts, Appleton or equal. Any wiring jacketing (insulation) shall be 100% lead-free. Provide lead-free cable as per Division 1 as an add alternate for team evaluation.
 - 1. Alternate material: PVC-free.

2.8 GROUND BARS

- A. Provide 36-inch wide by 4-inch high by ¼ -inch thick copper bus bar minimum, or size larger as necessary. Mount on walls in locations shown, on insulating standoffs, 18-inches above finished floor unless otherwise indicated.
- B. Provide U.L approved lugs for connecting grounding system cables. Attach lugs to bus with appropriate Grade 5. Bolt, lock washers and nuts. Torque all connections. All holes shall be drilled and tapped for two hole lugs. (single hole lugs may be acceptable where two hole lugs are unavailable) Provide 6 spare lugs and lug spaces unless otherwise noted.
- C. Ground Bars shall be manufactured by Erico Products, Inc., Chatsworth, or equal.
- D. Lugs shall be manufactured by Burndy, Thomas & Betts, IlSCO or equal.

2.9 GROUNDING CONDUCTORS

- A. System grounding conductors shall be a minimum of #4/0 AWG unless otherwise indicated, and shall be continuous without joints or splices.
- B. Bare conductors in direct contact with earth or encased in concrete: #4/0 AWG copper minimum unless otherwise noted.
- C. Ground conductors shall have green insulation. Where continuous color-coded conductors are not commercially available, provide a minimum 4" long color band with green, non aging, plastic tape in accordance with CEC.
- D. Bonding Pigtails: Insulated copper conductor, identified green, sized per code, and provided with termination screw or lug. Provide solid conductors for #12 AWG or smaller and stranded conductors for #10 AWG or larger.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Thoroughly examine site conditions for acceptance of grounding system installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.
- B. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

- A. Grounding conductors: Provide grounding electrode conductor and grounding equipment conductors as indicated on the drawings or sized per CEC Tables, whichever is greater.
- B. All metallic conduit stub-ups shall be grounded and where multiple stub-ups are made within an equipment enclosure, such as a switchboard, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.
- C. Use exothermic weld kits or burndy hyground compression connectors for below grade conductor splices and foundation steel connections. Use bolted connectors for above grade terminations. Use compression connectors or exothermic weld kits for above grade splices.
- D. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coating has been destroyed, which are subjected to corrosive action. Manufactured by Burndy "Penetrox" or equal.
- E. Power System Grounding: Provide, unless otherwise indicated, a main building reference ground bus at location shown on drawings. Connect the following items using CEC sized copper grounding conductors to lugs on the main building ground bus:
 - 1. Grounding electrode conductor from driven ground rods, concrete encased electrode, and supplementary grounding electrodes.
 - 2. Bonding conductor to metallic cold water piping system.

3. Bonding conductor to building structural steel.
- F. Separately derived electrical system grounding:
1. Ground each separately derived system per requirements in CEC as a minimum, unless greater requirements are stated elsewhere in the contract documents.
 2. Transformers: Provide a dual rated four or six-barrel grounding lug with a 5/8-11 threaded hole. Drill enclosure with 11/16" bit and attach lug to enclosure utilizing a torque bolt and a dragon tooth transition washer or equal. Connect the following when present:
 - a. Grounding electrode conductor.
 - b. Primary feeder ground.
 - c. Secondary feeder ground.
 - d. Main bonding jumper.
 - e. Isolated ground conductor (where applicable).
- G. Equipment Bonding / Grounding
1. Provide an insulated copper ground conductor sized in accordance with CEC requirements in all 120VAC through 600 VAC feeder and branch circuit distribution conduits and cables.
 2. Provide a separate grounding bus at panelboards, switchboards, and motor control centers. Connect all metallic enclosed equipment so that with maximum fault current flowing, shall be maintained at not more than 35 volts above ground.
 3. Conduit terminating in concentric, eccentric or oversized knockouts at panelboards, cabinets, gutters, etc. shall have grounding bushings and bonding jumpers installed interconnecting all such conduits.
 4. Conduit feeders terminating at all switchboards, distribution enclosures, panelboards, cabinets and gutters, etc. shall have grounding bushings and bonding jumpers installed interconnecting all such conduits.
 5. All conduit 1 ¼" and larger should have grounding bushings.
 6. Bond all receptacles to the boxes, raceways and grounding conductor.
 7. Provide grounding pigtails for bonding metal boxes to the ground system.
 8. Provide bonding jumpers across expansion and deflection couplings in conduit runs, pipe connections to water meters, dielectric couplings in metallic cold water piping system.
 9. Provide grounding and bonding conductors with sufficient slack to avoid breaking due to settlement and movement of conductors at attached points.
 10. Provide ground bars in all electrical rooms, sized as required, wall mounted at main and each electrical room with insulated standoffs.
 11. Provide bonding of the ground busses that belong to the normal and critical system panelboards serving the same patient vicinity in accordance with CEC 517-14.
 12. Provide grounding and bonding in patient care areas to meet requirements of NFPA 99 and ANSI/NFPA 70. Ground all outlets and equipment in accordance with CEC 517-13.
- H. Exothermic welding, Thomas & Betts non reversible I beam ground clamp connectors or Burndy Hyground compression connectors.
1. Exothermic welds or Burndy Hyground compression connectors shall be used for buried or concealed joints, cable-to-cable and cable to structural steel surfaces. Each particular type of weld shall use a kit unique to that type of weld.
 - a. Connections made outdoors shall be suitable for exposure to the elements.

- b. Connections made indoors shall use low smoke, low emissions “Cadweld Exolon” process.
 - c. All Buried or concealed joints shall be inspected and approved by the Inspector and the Owner’s Representative before concealment.
 - d. All materials involved shall be from the same source to insure compatibility.
2. Connections made with this process shall meet requirements of IEEE Standard 837 and other applicable specifications.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 26 00 80.
- B. Independent Testing agency shall perform all quality control electrical testing required herein.
- C. Pre-functional Testing
 - 1. Provide testing agency with contract documents for their review prior to the commencement of ground testing.
 - 2. Visual and mechanical inspection:
 - a. The testing agency shall inspect the grounding electrode and connections prior to concrete encasement, burial, or concealment.
 - b. Check tightness and welds of all ground conductor terminations.
 - c. Verify installation complies with the intent of the contract documents.
- D. Testing
 - 1. The resistance to ground for all systems shall be measured by the “direct” method or “fall of potential method.”
 - a. Perform “fall-of-potential” test per Institute of Electrical and Electronic Engineers (IEEE) Standard No. 81, Section 9.04 on the main grounding electrode or system.
 - b. Perform the 2 point method test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.
 - 2. Obtain and record ground resistance measurements both from electrical equipment ground bus to the ground electrode and from the ground electrode to earth.

3.4 ADJUSTMENTS

- A. Furnish and install additional bonding and add grounding electrodes as required complying with resistance limits specified under this Section of the Specification.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes Labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Conduit and equipment supports.
 - 2. Anchors and fasteners.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. NECA - National Electrical Contractors Association.
- B. California Electrical Code (CEC) 2016 Edition
- C. California Building Code (CBC) 2016 Edition

1.3 COORDINATION

- A. Coordinate size, shape and location of concrete pads with Section 03 3100.

1.4 QUALITY ASSURANCE

- A. Provide support systems that are adequate for the weight of equipment, raceways and cable systems and are in compliance with seismic requirements of the enforcement agency having jurisdiction (OSHDP).
- B. Install in accordance with manufacturer's instructions.

1.5 DESIGN RESPONSIBILITY

- A. Design support and anchorage system for raceways and equipment in accordance with OSHDP requirements and Section 26 00 10 requirements.
- B. Design supports for multiple conduits, capable of supporting combined weight of supported systems and system contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Design seismic-restraint hangers and supports for conduit and equipment.

- E. Supports, restraints and hangers are required to be pre-approved by OSHPD. Copies of the pre-approval details with "OPA" or "OPM" designation numbers must be on the jobsite prior to installation.

1.6 SUBMITTALS

- A. Shop Drawings: Signed and sealed by a qualified professional engineer for approval by OSHPD. 1/8" or 1/4" to 1'-0" scale drawings showing location and type of anchorage or support used keyed to the design details and mounting attachments to the structure. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze conduit hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Equipment supports.
- B. If there are locations within the project that cannot be addressed by OPM details contractor shall obtain services of a qualified professional engineer to design and document specific site required details and shall submit those for approval by the AHJ.
- C. Submit in accordance with the requirements of Section 26 00 10— BASIC ELECTRICAL REQUIREMENTS and with provisions of Division 01 — SUBMITTALS.
 - 1. Data / catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit manufacturer's installation instructions
 - 4. Anchors and attachments.
 - 5. Vibration isolation per Section 260548.
- D. Submit layout drawings, details, locations and structural calculations for support systems. Calculations shall be prepared and signed by a California registered Structural Engineer.
- E. Seismic bracing: submit information for the OSHPD pre-approved seismic bracing and anchoring system that will be used for the raceway installation. Refer to 26 00 10 for additional requirements related to CBC 1708A.

PART 2 - PRODUCTS

2.1 ANCHORS AND FASTENERS

- A. Expansion, Stud and Rod Coupling Anchors: Zinc plated carbon steel. Hilti Kwik Bolt TZ series, Powers Power-stud + SD2 or equal
- B. Adhesive Anchors: Self-Contained capsule with quartz sand, hardening agent and vinylester resin. Hilti HVA Adhesive System-HAS Series or equal. Adhesives shall comply with VOC limits in Division 1.
- C. Sleeve Anchors: Zinc plated carbon steel. Hilti HX series or equal.
- D. Plastic Screw Anchors: Screw size 10 by 1 inch, with Phillips head. Molded collar and ribs. Hilti PSA series or equal.
- E. Hollow Wall Anchors: Plated steel screw expansion anchor. Molly Bolt or equivalent.
- F. Shot pins and rods/wires.

2.2 CONDUIT FASTENERS

- A. Indoor Dry Locations: Plated straps and hangers.
- B. Outdoor, Damp and Wet Locations: Galvanized straps and galvanized hangers. Equip straps with clamp backs when installing to concrete or metal surfaces.
- C. OZ/Gedney, Thomas & Betts, minerallac, or equal.

2.3 SPRING FASTENERS

- A. Description: Fabricated from high carbon, sherardized annealed stripped steel.
- B. Loading: Manufactured to withstand a load equal to 3 times the specified rating.
- C. Finish: Corrosion resistant coating that meets the 72-hour salt spray rust test criteria.
- D. Erico "Caddy", B-line or equal.

2.4 CONCRETE INSERTS

- A. Pressed galvanized steel, spot insert, with oval slot capable of accepting support nuts of 1/4-inch to 1/2-inch diameter thread.
- B. Unistrut No. M24 with "M2506" series nut; Superstrut No. 425 with "AB-102" series nut, Kinline No. 279 with "660" series nut, or equal.

2.5 DECK INSERTS

- A. Steel plate 3/16-inch thick with threaded galvanized steel rod sized for load.
- B. Superstrut No. C-475 series, Kinline No. 293 series, Blue Bangers, Tolco 109A Deck Insert, or equal.

2.6 CONSTRUCTION CHANNEL

- A. 1-1/2 inch by 1-1/2 inch, 12-gauge electro-galvanized steel channel with 9/16-inch diameter bolt holes, 1-7/8 inch on center, in the base of the channel.
- B. SuperstrutA-1200-P, Unistrut P-1000-HS, Kinline 4112-PO, or equal.
- C. Fittings, nuts and bolts: Manufactured for steel channel use, electrogalvanized finish.

2.7 THREADED ROD

- A. Galvanized rod, sized for the load unless otherwise shown or specified.

2.8 CABLE TIES AND CLAMPS

- A. Thomas and Betts Co. "Ty-Raps," Panduit "Pan-ty" or equal, one piece, nylon, reusable tape lashing ties.

2.9 BEAM CLAMPS

- A. Beam clamps shall attach to both flanges of a beam, provide single or double-flange type clamps. For single flange type only, type with retaining straps and UL listed are acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide supporting devices as noted here and in other Sections of Division 26.
- B. Install products in accordance with manufacturer's instructions.
- C. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- D. Fasten hanger rods, conduit clamps, outlet and junction boxes to building structure using precast inserts, expansion anchors, preset inserts or beam clamps.
- E. Use adhesive or expansion type anchors for heavy duty load installations into concrete construction.
- F. Use adhesive type anchors for heavy duty vibratory loading installations into concrete construction.

- G. Use expansion type anchors for medium duty load installations into concrete construction.
- H. Use sleeve type anchors for medium duty load installations into solid brick or concrete block construction.
- I. Use plastic type anchors for light duty load installations into concrete, solid brick or masonry block construction. Light duty applications:
 - 1. Metal surface raceways or multioutlet assemblies.
 - 2. Outlet boxes.
 - 3. Support EMT, 1 inch and smaller, using 1 or 2 hole strap.
 - 4. Support 1/2 inch rigid conduit or IMC using 1 or 2 hole strap.
- J. Use plastic or hollow wall type anchors for installation of surface raceways or multioutlet assemblies into plaster wall construction.
- K. Use hollow wall anchors for light duty load installations into plywood or concrete hollow block construction.
- L. Stud Wall Construction: Fasten conduit support straps, surface raceways or multioutlet assemblies directly to metal stud using size 10 pan head sheet metal screws.
- M. Do not support conduit, surface raceways, multioutlet assemblies or boxes to wallboard using plastic or hollow wall anchors.
- N. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit
- O. Spring steel clips and clamps:
 - 1. Cable support: Use for above suspended ceiling attachment to rods or walls, and inside stud walls.
 - 2. Conduit support: Use for above suspended ceiling attachment to rods. Permitted for EMT conduit sizes 1/2-inch through 1 1/4 -inch.
 - 3. Do not use for rigid conduit support.
 - 4. Do not use for exposed work.
 - 5. Do not attach to ceiling wires.
- P. Obtain permission from Architect/Engineer before drilling or cutting structural members.
- Q. Fabricate supports from structural steel or steel channel that is UL listed. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- R. Install surface-mounted cabinets and panelboards with minimum of 4 anchors.
- S. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
- T. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- U. Support vertical conduit at every floor with a maximum of 10-feet between supports.

- V. Use beam clamps for supporting from steel beam flanges.
- W. Provide concrete inserts to support minimum 1/4-inch rod grid above suspended ceilings for conduit and cable support. Use 4 foot on centers for grid layout.
- X. Fasten to drywall by screw attachment to wall stud. Do not attach to drywall using anchors or molly bolts.
- Y. Do not fasten conduit or cable to ceiling wire. Do not use ceiling wire as substitute for rod above suspended ceilings.
- Z. Powder actuated anchoring system for anchoring purposes in lieu of inserts is permissible where approved by OSHPD.
- AA. Low voltage cable support above concealed ceilings: Use J-hooks down main corridors with 5 foot on center spacing. Use spring clip with bridle ring, attached to rod, for other locations.
- BB. Provide seismic bracing in accordance to OSHPD requirements.
- CC. Anchor free-standing equipment on concrete pads where indicated.
- DD. Nails, Rawl Plugs, or wood plus shall not be permitted.
- EE. Provide vibration isolation as per the Division 26 Vibration and Seismic Controls for Electrical specification.

3.2 LAYOUT

- A. Layout support devices to maintain headroom, neat mechanical appearance and to support equipment loads.

END OF SECTION

SECTION 26 05 34 CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Rigid steel conduit and fittings.
 - 2. Electrical metallic tubing and fittings.
 - 3. Flexible metallic conduit and fittings.
 - 4. Liquid tight flexible metallic conduit and fittings.
 - 5. Rigid non-metallic conduit and fittings.
 - 6. PVC insulated rigid steel conduit and fittings.
 - 7. Miscellaneous conduit fittings and products.

- B. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified.
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.
 - 2. ANSI C80-3 - Electrical Metallic Tubing, Zinc-Coated.
 - 3. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
 - 4. California Electrical Code (CEC) 2016 Edition
 - 5. California Building Code (CBC) 2016 Edition
 - 6. FS WW-C-563A - Electrical Metallic Tubing.
 - 7. FS WW-C-566 - Specification for Flexible Metal Conduit.
 - 8. FS WW-C-581 - Specification for Galvanized Rigid Conduit.
 - 9. NEMA RN 1 - PVC Externally-Coated Galvanized Rigid Steel Conduit.
 - 10. NEMATC2 - Electrical Plastic Tubing and Conduit.
 - 11. NEMATC3 - PVC Fittings for Use with Rigid PVC.
 - 12. UL 1 - Flexible Metal Conduit.
 - 13. UL4 - Armored Cable.
 - 14. UL6 - Rigid Metal Conduit.
 - 15. UL651 - Rigid Nonmetallic Electrical Conduit.
 - 16. UL797 - Electrical Metallic Tubing.
 - 17. UL 1242 - Intermediate Metal Conduit.

- B. Related Sections:

1. Division 01 for recycling requirements.
 2. Division 01 for dust and pollutant control requirements.
 3. Division 01 for VOC limits, recycled content, regional materials, and other sustainable design requirements.
- C. Submit cut sheets of product in accordance with 26 00 10.
- D. Seismic Bracing: Submit seismic bracing and anchoring system including calculations that shall be used for the raceway installation for OSHPD review and approval. The calculations shall be stamped and signed by a Structural Engineer registered in the State of California. It is the contractor's responsibility to prove these systems comply with CBC section 1632A.6.

1.3 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new.
- B. Only products and applications listed in this Section may be used on the project unless otherwise submitted and approved by the Owner's Representative.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Division 01 - PRODUCT OPTIONS AND SUBSTITUTIONS.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

1.5 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

- A. General Requirements:
 1. Conduit and wireways manufactured under supervision of UL Factory Inspection and Label Service, with UL label and manufacturer's name on each length of conduit over 1-1/2".

2. Fittings: Conform to same requirements as conduit, except as specified herein.

2.2 RIGID METAL CONDUIT AND FITTINGS

- A. Galvanized Rigid Conduit (GRC): ANSI C80.1, full weight steel, threaded, hot-dipped galvanized, or sherardized both inside and out after threading, with threaded connectors and couplings and approved compression connectors and couplings.
 1. Manufacturers:
 - a. Allied
 - b. Western
 - c. Republic
 - d. Wheatland
 - e. Picoma
 - f. Triangle
 - g. Or equal.
- B. PVC Coated Conduit: NEMA RN 1; Rigid steel conduits and fittings with a half lap, 40 mil extruded PVC jacket. The jacket shall have high tensile strength, shall be highly resistant to corrosion and shall not oxidize or deteriorate or shrink when exposed to sunlight and weather. The jacket shall be flame retardant and shall not support combustion. The interior of conduit and fittings shall be coated with urethane coating (two mil thickness) for protection against corrosion.
 1. Manufacturers:
 - a. Robroy Industries PLASTI-Bond Red”
 - b. Ocal Corporation Ocal-Blue”
 - c. Or equal.
 2. Alternate material: PVC-free.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; threaded type and threadless compression type.
 1. Rigid steel fittings: Acceptable Manufacturers: Raco, Steel City/Thomas & Betts, Appleton, Crouse-Hinds/Midwest, O.Z., Bridgeport, EGS
 - a. Three-piece Couplings: Zinc-plated, malleable iron. OZ/Gedney “4-” series, Thomas & Betts “675” series or equal.
 - b. Hubs: Zinc-plated, malleable iron, with insulated throat. OZ/Gedney “CHM-T” series, Thomas & Betts “401” series or equal.
 - c. Insulated Bushings: Zinc-plated, malleable iron, with 150 degrees C rated, molded-on high impact phenolic thermosetting insulation. OZ/Gedney “B” series, Thomas & Betts “BIM” series, or equal.
 - d. Insulated Grounding Bushings: Zinc-plated, malleable iron, with 150 degrees C rated, molded-on phenolic insulation and tin plated copper saddle for grounding conductor. OZ/Gedney “BLG” series, Thomas & Betts “3870” series or equal.
 - e. Expansion Fittings: Up to 2 inches, OZ/Gedney “TX” series or equal in open areas and “TX” together with “DX” series or equal in cored openings. Above 2 inches, OZ Gedney “AXS” series or equal in open areas and “AXS” together with “DX” series or equal in cored openings. All fittings complete with bonding jumper.
 - f. Set screw fittings and die cast or pressure cast fitting are not permitted. Threadless compression fittings shall be heavy duty steel or malleable iron/zinc plated.
 2. Conduit bodies: Zinc plated, malleable iron with tapered threaded hubs. OZ/Gedney “LB-50” series, Appleton “LB-50” series or equal.

- D. Utilize aluminum raceways in 400 or 415 Hz systems, in areas subject to magnetic field in excess of .5 Gauss or as noted herein.

2.3 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

- A. Conduit: Galvanized steel.
 - 1. Manufacturers:
 - a. Allied
 - b. Republic
 - c. Western
 - d. Wheatland
 - e. Picoma
 - f. National
 - g. Triangle
 - h. Or equal.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; Provide threaded type, steel or malleable iron fittings for conduits 2 ½” and larger. Provide steel or galvanize iron set screw fittings for conduit 2” or smaller. KWIK-COUPLE conduit and elbows that meet all applicable codes and standards shall be permitted.
- C. Threaded intermediate metal conduit may be substituted for rigid steel conduit, unless specifically excluded in this specification or in the CEC.

2.4 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Electric Metallic Tubing (EMT): ANSI C80.3, high-grade steel, formed of cold rolled strip steel, electrical resistance welded, hot dip galvanized, applied by the electro galvanized process. Interior of surface coated with aluminum lacquer or enamel. EMT shall be dipped in a chromic acid bath to chemically form a corrosion-resistant protective coating of zinc chromate over galvanized surface.
 - 1. Manufacturers:
 - a. Allied
 - b. Wheatland
 - c. Western
 - d. National
 - e. Triangle
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; concrete tight, compression or set screw type for interior dry locations. KWIK-fit conduit and elbows that meet all applicable codes and standards shall be permitted.
 - 1. Connectors: Zinc plated, steel body with malleable iron nut and insulated throat except that body of compression ring type fittings only may be pressure cast. Pressure cast materials for nuts of compression ring type fittings, or for any part of other types of fittings are not acceptable.
 - 2. Couplings: Zinc plated steel.
 - 3. Conduit Bodies: Die cast, copper-free aluminum with set-screw hubs. OZ/Gedney “LB-50A-TW series, Appleton “LB-50T-A” series, Thomas & Betts or equal.

2.5 FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Conduit: Fabricated in continuous length from galvanized steel strip, spirally wound and formed to provide an interlocking design.
 - 1. Manufacturers:
 - a. AFC
 - b. Alflex
 - c. Or equal.
- B. Fittings: ANSI/NEMA FB 1, steel or malleable iron with insulated throat. Thomas & Betts "Tite-Bite 3110 series, OZ Gedney "KC-50T" series or equal.
- C. Provide flexible metallic conduit for termination at equipment subject to motion or vibration, and from outlet box to recessed light fixture and equipment from normal and emergency power.

2.6 LIQUIDTIGHT FLEXIBLE CONDUIT AND FITTINGS

- A. Conduit: Liquid-tight conduit shall be manufactured from interlocked steel construction with standard weight steel, hot dipped galvanized on all four sides prior to conduit fabrication, and shall be provided with an extruded polyvinyl chloride cover. Conduit and fittings shall provide positive ground continuity. Include a separate ground conductor for each circuit.
 - 1. Manufacturers:
 - a. Sealtite Flexible, Type "UA"
 - b. Flex-Seal, Type "XL"
 - c. Alflex
 - d. AFC
 - e. Or equal.
 - 2. Alternate material: PVC-free.
- B. Fittings: ANSI/NEMA FB 1, steel or malleable iron with nylon insulated throat. Thomas & Betts "5330" series, OZ Gedney "4Q-50T" series or equal.

2.7 PLASTIC CONDUIT AND FITTINGS

- A. Conduit: Rigid polyvinyl chloride conduit, Schedule 40, conforming to NEMA TC 2 and listed for exposed and direct burial applications. With integral belied ends on straight sections and elbows.
 - 1. Manufacturers:
 - a. Carlon
 - b. JM Manufacturing/Eagle
 - c. PW Pipe
 - d. Prime
 - e. Kraloy
 - f. Canon Plus 40
 - g. Or equal.
 - 2. Alternate material: PVC-free.
- B. Fittings and Conduit Bodies: NEMA TC 3.

- C. For any turns over 30°, use long radius elbow.

2.8 MISCELLANEOUS

- A. Sleeves shall be zinc coated galvanized steel pipe or Hilti type CB-680 or 3M type MCID or 16 gauge galvanized sheet metal.
- B. Sealant: Fire rated equal to wall or ceiling penetrated. Silicon foam Dow-Corning #2001, 3M, "Pensil #851, or approved equal. Sealant compound for exterior walls shall be moisture resistant material made by 3M, GE, Dow-Corning or equal.
- C. Conduit seals shall be Crouse-Hinds Type "EYS" or EZS," Appleton Type "ESUF" or "ESUM" or approved equal, with sealing compound as recommended by the manufacturer for hazardous or refrigerated areas.
- D. Expansion couplings shall be OZ Type "AX" or "DX" Crouse-Hinds Type "XJ" or "SD" or equal, complete with bonding jumper.
- E. Conduit unions shall be "Erickson" couplings manufactured by Thomas and Betts, Type 4-Series manufactured by O-Z/Gedney or equal.

2.9 CONDUIT SUPPORTS

- A. Conduit Clamps, Straps, and Supports: See Section 26 0529- HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.

2.10 WIREWAYS

- A. Provide sheet metal wireways with hinged covers as indicated on the drawings. Screw cover for wireways shall be allowed with approval of the EEOR.
- B. Wireways shall be NEMA type as indicated on Drawings, complete with couplings, off sets, elbows, expansion joints, adapters, hold down straps, end caps, and other fittings as required.

2.11 PULL LINE

- A. 1/8" diameter braided line of yellow polypropylene, or Jet-Line #332 or equal, line of continuous fiber polyolefin; minimum breaking strength, 200 lbs. Furnish and install pull line in all empty (unused) raceways.

2.12 OTHER FITTINGS

- A. Raintight Unions: Appleton or Crouse-Hinds Type UNF or equal.
- B. Concrete Tight Couplings: O.Z. Type SSP, T & B "Erickson" coupling or equal.
- C. Watertight Connectors:
 - 1. Meyers watertight hubs.

- 2. Midwest or T&B watertight locknuts with O.Z./Gedney Type B bushings.
- 3. Threaded fittings.

- D. Insulated Bushings for EMT: O.Z./Gedney Type SB, Arlington or equal.
- E. Insulated Compression Box Connector for EMT: O.Z./Gedney 7000 series or equal.
- F. Sealing Bushings: O.Z./Gedney Type CSMI Series sealing bushings or equal for rigid galvanized steel.
- G. Seal-off Fittings: Crouse-Hinds, Appleton or equal.

PART 3 - EXECUTION

3.1 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. Size conduit per CEC for conductor type installed or for Type THWN/THNN conductors, whichever is larger; 3/4-inch minimum size.
- B. Arrange conduit to maintain headroom and present a neat appearance.
- C. Route exposed conduit parallel and perpendicular to walls and adjacent piping.
- D. Maintain minimum 2 inch clearance between conduit and non heat generating and insulated domestic hot water piping that runs parallel for more than 5'-0". Maintain at a minimum 6 inch clearance between conduit and steam piping that runs parallel for more than 5'-0". Maintain 12-inch clearance between conduit and heat sources such as flues and heating appliances.
- E. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, dedicated ceiling wires for conduit, bolted split stamped galvanized hangers, or approved means and methods allowed by code. Dedicated ceiling wires shall be identified in some fashion to distinguish them as different from ceiling support wires.
- F. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit for like type conduits on racks. Where space for 25 percent is not obtainable a reduction is acceptable with the approval of the EEOR.
- G. Do not fasten conduit with perforated pipe straps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.

3.2 CONDUIT INSTALLATION

- A. Cut conduit square using a saw or pipe cutter; de-burr cut ends.
- B. Bring conduit to the shoulder of fittings and couplings, fully seat and fasten securely.
- C. Use conduit hubs for fastening threaded conduit to sheet metal boxes, and for fastening conduit to enclosures in damp or wet locations.

- D. Use conduit bodies to make sharp changes in direction, as around beams.
- E. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch size.
- F. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.
- G. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.
- H. Provide 1/8" diameter braided line of yellow polypropylene, or Jet-Line #332 or equal, line of continuous fiber polyolefin, minimum breaking strength, 200 lbs. Furnish and install in ALL empty (unused) raceways, conduits.
- I. Install expansion-deflection joints or flexible conduit with junction box where conduit crosses building expansion or seismic joints.
- J. Where conduit penetrates fire-rated walls and floors, provide fire-stop assembly with UL listed fire rating equal to wall or floor rating.
- K. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack or pitch pocket.
- L. Maximum Size Conduit in Slabs Above Grade: As allowed in Divisions 3 and 5.
- M. PVC schedule 80 elbows are acceptable to use for under slab conduit runs 70 feet or less with less than 270 degree (power), 180 degree (IT) total bends. Use PVC-coated rigid steel factory elbows for bends in conduit runs longer than 70 feet, or in plastic conduit runs which have more than three bends regardless of length. PVC schedule 80 elbows are acceptable for penetrating concrete slab under free standing switchgear provided PVC is flush with concrete surface and the electrical contractor uses proper fittings. This applies only to PVC conduits runs less than 70 feet and 270 degree bends or less. Use PVC coated rigid steel factory elbows for vertical bends and slab penetrations in all other plastic conduit runs.
- N. Wipe plastic conduit clean and dry before joining. Apply full even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.
- O. Final connections to electric motors and other vibration isolated equipment: use steel flexible (in dry locations) and flexible liquid-tight (in damp or wet locations) conduit of sufficient length to provide right angle bend or 8 inch offset between motor or equipment and first rigid anchor point.
- P. Provide conduit for low voltage systems installed in exposed areas.
- Q. Install flexible conduit at all vibration isolated equipment as per the Division 26 Vibration and Seismic Controls or Electrical specification.

3.3 DUCTBANK

- A. Install top of duct bank minimum 30 inches below finished grade.
- B. Terminate conduit in end bell at manhole entries.

- C. Use suitable separators and chairs installed not greater than 5 feet on centers. Band conduit together with suitable separators and chairs Securely anchor conduit to prevent movement during concrete placement.
- D. Provide minimum 3 inch concrete cover at bottom, top, and sides of duct bank for encasement outside of building footprint or under foundation elements.
- E. Branch power circuits and low voltage are not required to meet ductbank requirements when less than 6 conduits share a common trench.

3.4 CONDUIT INSTALLATION SCHEDULE

- A. Underground Installations within 5 feet of building: Schedule 40 plastic conduit encased in concrete or PVC coated rigid steel conduit.
- B. Installations In or Under Concrete Slab, or Underground more than 5 feet from building: Schedule 40 plastic conduit encased in 2 sack sand slurry or PVC coated rigid steel. No encasement is required under concrete slab if PVC schedule 80 is used. Non metallic raceway shall not be used for branch circuits that supply patient care areas.
- C. In Concrete (where allowed): Rigid steel conduit.
- D. Exposed Outdoor Locations: Rigid steel conduit, or Intermediate metal conduit.
- E. Wet or Damp Interior Locations: Rigid steel conduit or Intermediate metal conduit.
- F. Concealed Dry Interior Locations: EMT with set screw connectors.
- G. Crawl space location braced on the Floor: Rigid steel conduit or intermediate metal conduit.
- H. Crawl Space location hung from the deck above: EMT with set screw connectors.
- I. Exposed Dry Interior Locations below 8 feet: Rigid steel conduit *or* Intermediate metal conduit. EMT may be used in lieu of rigid conduit if not subject to physical damage as defined by the CEC.
- J. Conduit system mechanically and electrically continuous from outlet to outlet and to all cabinet junction or pull boxes. Secure conduits to all boxes and cabinets so all parts have electrical continuity.
- K. Where specific sizes required by Drawings or Specifications are larger than Code requires, larger size shall be installed.
- L. Do not use conduit bodies for conduits larger than 2 inches unless they are of the mogul design, and are supported within 36 inches of the conduit body.
- M. Provide four empty 3/4 inch conduit for spare circuits for each flush mounted panelboard. Terminate conduit in an accessible location (ceiling space above panelboard) for future extension.
- N. Minimum conduit sizes are as follows:
 1. Power and Control: 3/4", unless otherwise noted on the drawings.
 2. Communication/Data: 1 1/4", unless otherwise noted on the drawings.

3. Signal Systems: ¾", unless otherwise noted on the drawings.
- O. Provide conduit bending and elbows as noted below:
1. Power Feeders (600V): At a minimum comply with Chapter 9 Table 2 of the CEC .
 2. Branch Circuits: At a minimum comply with Chapter 9 Table 2 of the CEC .
 3. Power Feeders (above 600V): At a minimum comply with Chapter 9 Table 2 of the CEC
 4. All 90° elbows for all conduits including and over 2" trade diameter shall be standard factory radius minimum.
 5. Power feeders, branch circuits, and signal circuits 600 V and below use UL listed factory elbows.
 6. All field bends for rigid conduit shall be made by either hickey-style benders for 1" and smaller conduits or by one-shot hydraulic benders for conduits larger than 1". Manufactured specifically for the purpose.
 7. Provide no more than 4 - 90° bends between pull or junction boxes for power wiring conduit run. Provide no more than 4 - 90° bends between pull or junction boxes for underground power wiring conduit run. Provide no more than 2 - 90° bends for underground low voltage data/telecom conduit run.
 8. Flexible steel conduit length shall not exceed 9 feet. Provide sufficient slack to reduce the effect of vibration.
- P. Run all exposed raceways parallel to and at right angles to building lines.
- Q. Do not regroup conduit runs and circuiting homeruns except by special permission.
- R. Group raceways as much as possible.
- S. Raceways Embedded in Floor Slabs.
1. Only where specifically shown on Drawings.
 2. Raceways shall not be installed in slab without the approval of the Structural Engineer.
 3. Raceways shall not interfere with placement of floor slab reinforcement components.
 4. Install raceways between the upper and the lower layers of reinforcing steel.
 5. Space raceways not less than 8 inches on centers except where they converge at panels or junction boxes.
 6. Raceways running parallel to slab supports, such as beams, columns and structural walls, shall be installed no closer than 12 inches from such supporting elements.
- T. Raceway Above Suspended Ceiling: In general, install conduit 1'-0" minimum above top of ceiling.
- U. Rigid Steel Conduits Subject to Corrosion:
1. The following methods of installation will be accepted as meeting the requirements of NEC Section 300-6. Alternate methods will be considered in order to meet local building codes. The installation methods are as follows:
 - a. In Concrete: Rigid steel conduit and fittings may be used in concrete above grade and in concrete resting on the ground provided a minimum concrete cover of 2 inches is maintained. Aluminum conduit and fittings are not permitted in concrete.
 - b. In Earth: Rigid steel conduit installed in earth is to be protected from corrosion with a factory-applied coating or approved field coating. Aluminum conduit and fittings are not permitted.
 - c. In Corrosive and Wet Atmosphere: Rigid metal used is to withstand the exposure involved.

2. Field wrapping requirements are as follows:
 - a. Install a double, half-lap tape wrap, each wrap in opposite direction. Start half laps at the middle.
 - b. Material approval is based on the mil gauge, film material, tensile strength, stretch, adhesion, chemical and physical resistance of film, dielectric strength and electrolytic corrosion. Materials listed in the IAPMO Directory are considered approved materials and include 20 mil polyvinyl or polyethylene tape.
 - c. Surface Preparation: Oil, grease, rust, scale, moisture, or other foreign material shall be removed by approved paint removers, caustic dips, hand tools, solvents, or other appropriate means. Oil-base solvents shall not be used. Hexane, Toluene, Xylol, etc., are acceptable. After cleaning, the pipe is to be kept free of all oil, grease, dirt, and moisture.
 - d. Priming: A coat of primer adhesive is to be applied over cleaned pipe when specified in the manufacturer's directions.

- V. Install no more than one coupling or device between supports. Two couplings are permissible when an offset bend is required max 10' between supports

- W. Coordinate conduit openings in walls and floors. Install sleeves shown on the drawings when the concrete is poured. Any openings required after the concrete has set, may be core drilled. Do not cut any structural supports or rebar.

- X. Conduits crossing building expansion joints shall be provided with UL listed expansion fittings. In interiors above ceilings, flexible metal conduit is an acceptable substitute.

- Y. Install conduit seals at boundaries where ambient temperatures differ by 10°F or more as shown on the drawings. Install seals on warm side of partition.

- Z. Run conduit on any equipment in parallel with or perpendicular to the equipment and in such a manner as to:
 1. Not be exposed to damage.
 2. Not interfere with access to components of the equipment that will interfere with maintenance operation.
 3. Not be detrimental to the operation.

- AA. Provide metallic raceways with bushings, threaded or compression type, as follows:
 1. Stubups into switchboard or other floor mounted equipment: Insulated type with grounding lug.
 2. Feeder raceway connections at panels, transformers, etc.: Insulated type.
 3. Branch circuits, control raceways, etc., terminating at panels, motor control centers, backboards: Plastic insulated type. Except when insulated throat connectors are used.
 4. Provide grounding bushings as required by NEC (CEC) 517 on all feeder conduit in critical care areas and on conduit for feeders #8 AWG and larger.

- BB. Provide metal pipe sleeves for crossing at fire rated walls. Install UL listed fire-stop whenever a raceway penetrates a fire wall. See Architectural drawings for locations of rated assemblies and Architectural Drawings for penetration details.

- CC. Install conduit seals and drains to prevent accumulated moisture in conduits from entering electrical equipment enclosures.

- DD. Provide conduit routing and slope to prevent drainage into equipment for underground conduit.
- EE. Treat cut ends of conduit, scratches, tool marks, etc. on any metallic raceway installed in the ground or on the exterior of the building with two coats of CRC "Zinc-It", or equal.
- FF. Metallic conduit stubbed up into substations or switchgear shall terminate into a grounding bushing located a maximum of 3" above concrete pad and within the switchgear.
- GG. Seal raceways penetrating an exterior building wall to prevent moisture and vermin from entering into the electrical equipment.
- HH. Slope exterior raceways to manholes or pullboxes a minimum of 1" per 8'. Double slope long runs from center point.
- II. Cap ends of conduit to prevent entrance of water and other foreign material during construction.
- JJ. Complete and swab clean conduit systems before pulling conductors.
- KK. Provide cable supports in conduits rising vertically in accordance with CEC Article 300.
- LL. Seal conduits which pass through floor slabs (except ground floor) with intumescent materials to prevent the passage of fire and smoke. Use products specified in Part 2.
- MM. Install vertical runs for emergency system feeder conduits in 2 hour enclosures in accordance with applicable high rise codes.
- NN. Failure to route conduit through building without interfering with other equipment and construction shall not constitute a reason for an extra change. Equipment, conduit and fixtures shall fit into available space in the building and shall not be introduced into building at such times and manner as to cause damage to structure. Equipment requiring service shall be readily accessible.
- OO. Keep 277/480 volt wiring independent of 120/208 volt wiring, and all power wiring. Keep power wiring independent of communication system wiring. Keep emergency system wiring independent of other wiring systems.
- PP. Keep life safety, critical branch and equipment systems wiring independent of other systems.
- QQ. PVC Conduit Bending:
 1. Bends 30 degree and larger for PVC conduit systems shall be long radius bends.
 2. Field bending, not exceeding 30 degrees is allowed for PVC conduit 2" trade size or smaller. Use electric heat box or hot air blower specifically designed for bending PVC conduit; bending by means of open flame is not acceptable.
- RR. Flexible conduit shall be electrically continuous from outlet or conduit end to utilization equipment.
- SS. Provide liquid type flexible metal conduit for termination at equipment subject to motion and vibration, and where exposed to continuous or intermittent moisture.
- TT. Provide equipment grounding conductor and drip loop in all connections to vibrating equipment. Bond the grounding conductor to the outlet and to the device.

- UU. Duct banks shall be installed with factory made snap-lock spacing assembly installed a maximum of five feet on centers to maintain a uniform 3" spacing between ducts or the ground. Do not install spacers within 12" of joints. Duct banks are defined as two or more raceways in a common trench excluding branch circuit raceways where less than 6 conduits are routed in a common trench.
- VV. Provide dual orange, CAL-OSHA approved warning tapes stating "High Voltage" on top layer of duct bank.
- WW. Provide equipment grounding conductor in all PVC conduit runs containing power conductors.
- XX. No PVC shall emerge from the ground or the concrete slab or encasement. PVC shall convert to galvanized rigid metal prior to its emergence.
- YY. Stubups for underground PVC conduit or duct shall be rigid steel conduit.
- ZZ. Install sealing bushings in all conduit runs passing between existing and new building.
- AAA. Install expansion fittings in all conduit runs passing between existing and new building adjacent walls or across any building expansion joints.

END OF SECTION

SECTION 26 05 37 BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes Labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Wall and ceiling outlet boxes.
 - 2. Pull and junction boxes.

- B. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified.
 - 1. ANSI/NFPA 70 - California Electrical Code (CEC).
 - 2. ANSI/NEMA FB-1 - Fittings and Supports for Conduit and Cable Assemblies.
 - 3. ANSI/NEMA 05-1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
 - 4. ANSI/NEMA OS-2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
 - 5. NEMA 250 - Enclosures for Electrical Equipment (1000 volts maximum).
 - 6. California Electrical Code (CEC) 2016 Edition
 - 7. California Building Code (CBC) 2016 Edition

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 26 00 10- BASIC ELECTRICAL REQUIREMENTS and under provisions of Division 01 - SUBMITTALS.
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Submit manufacturer's installation instructions.
 - 4. Submit (1) sample for all floor boxes.

1.4 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.

- B. Verify locations of floor boxes and outlets prior to rough-in.

- C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.
- D. Identify where outlet boxes occur in all sound-isolating constructions (i.e. wall, ceiling, and floor assemblies, etc.). Install sound barrier pad products as specified in Section 09 81 33 Acoustic Insulation and Sealant, and as specified and per manufacturer instructions.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA 05 1, galvanized steel. Minimum size 4 inches square and 1-1/2" deep, unless otherwise noted.
 - 1. Manufacturers:
 - a. Steel City
 - b. Raco
 - c. Or equal.
 - 2. Luminaire and equipment supporting boxes: Rated for weight of equipment supported; include 3/8-inch male fixture studs where required.
 - 3. Concrete ceiling boxes: Concrete type, 4 inch octagonal.
- B. Cast Boxes: NEMA FB 1, Type FD or "Bell boxes" cast ferroalloy with threaded hubs. Provide gasketed cover by box manufacturer. Manufacturers: Appleton, Crouse-Hinds or equal.

2.2 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA 05 1, galvanized steel.
 - 1. Manufacturers:
 - a. Steel City
 - b. Raco
 - c. Or equal.
- B. Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box.
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- C. In-Ground Cast Metal Box for Pedestrian or Light Vehicular Traffic Areas: NEMA 250, Type 4, flanged, recessed cover box for flush mounting.
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 - 3. Cover legend: ELECTRIC, unless otherwise noted.
 - 4. Manufacturers: Crouse-Hinds, Appleton or equal.
- D. Precast Concrete Handholes for Vehicular Traffic:
 - 1. Concrete handhole complete with body, cover, solid base and necessary extensions.

2. Cover shall be superimposed steel traffic type and secured with recessed hold-down bolts.
3. Size of handholes as indicated on drawings.
4. Cover legend: ELECTRIC, unless otherwise noted.
5. Manufacturers:
 - a. Christy
 - b. Oldcastle/Utility Vault

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify locations of floor boxes and outlets prior to rough-in.

3.2 INSTALLATION

- A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- B. Install electrical boxes in accordance with "NECA Standard of Installation", to maintain headroom and to present neat mechanical appearance.
- C. Set wall mounted boxes at elevations to accommodate mounting heights indicated for outlet devices.
- D. Install junction, pullboxes, or condulets where required to limit bends in conduit runs to not more than 360 degrees or where pulling tension achieved would exceed the maximum allowable tension.
- E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- F. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 18 inches from ceiling access panel or as defined as accessible by the CEC.
- G. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Section 07 84 00 - FIRESTOPPING.
- H. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
- I. Install flush mounted box without damaging wall insulation or reducing its effectiveness.
- J. Use gang box where more than one device is mounted together. Do not use sectional box.
- K. Use 4-inch square box with plaster ring for single device outlets.
- L. Use cast outlet box in exterior locations and wet locations.
- M. Use Stamped steel floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- N. Set floor boxes level.

- O. Large Pull Boxes: Boxes larger than 1200 cubic inches in volume, or 16 inches in any dimension. Screw cover shall be acceptable when the hinged cover cannot swing completely open.
 - 1. Interior Dry Locations: Use hinged enclosure.
 - 2. Other Locations: Use surface-mounted cast metal box.
- P. Box color coding and marking. Refer to Section 26 05 53- IDENTIFICATION FOR ELECTRICAL SYSTEMS, for instructions.
- Q. Outlet boxes installed in acoustically rated partitions shall be provided with sound barrier pads installed in strict accordance with the architectural drawings, manufacturer instructions, and specification section 09 81 33 ACOUSTIC INSULATION AND SEALANTS.

3.3 OUTLET BOX LAYOUT

- A. Locate pullboxes and junction boxes in concealed locations above removable ceilings or exposed in electrical rooms, utility rooms or storage areas.
- B. Install outlet boxes at the locations and elevations shown on the Drawings or specified herein. Make adjustments to locations as required by structural conditions and to suit coordination requirements of other trades.
- C. Locate switch outlet boxes on the latch side of doorways unless otherwise indicated.
- D. Locate outlet boxes, above hung ceilings having concealed suspension systems, adjacent to openings for removable recessed lighting fixtures.
- E. Back-to-back -outlet boxes installed in acoustically rated partitions shall be separated by 16 inches unless specifically shown on the drawings.

3.4 SUPPORTS

- A. Use stamped steel bridges to fasten flush mounting outlet box between studs. Caddy SGB series or PW industries wall brackets or equal.
- B. Use stamped steel bridges or quick mount box support with far side leg support to fasten flush mounted outlet box to adjacent stud. Unimount or Caddy SGB or PW industries floor bracket or H series or equal.
- C. Do not use outlet boxes having ears for fastening to studs. All boxes shall have at least two points of support from a structural element or wall stud.
- D. Do not fasten boxes to ceiling support wires. Use shotpins and independent support wires.
- E. Support boxes independently of conduit.
- F. Use adjustable steel channel fasteners for gypsum board or plaster hung ceilings. Attach bars to main ceiling runners.
- G. Support boxes located above accessible suspended ceilings from structure. Do not attach to the ceiling support runners.

3.5 ADJUSTING

- A. Adjust in accordance with the requirements of Division 01 – QUALITY CONTROL.
- B. Adjust floor box flush with finish flooring material
- C. Adjust flush-mounting outlets to make front flush with finished wall material.
- D. Install knockout closures in unused box openings.

3.6 CLEANING

- A. Comply with requirements of Division 01 - CLEANING.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

3.7 COMMISSIONING

- A. Insure that box color-coding and marking in compliance with Section 26 05 53- ELECTRICAL IDENTIFICATION requirements.

END OF SECTION

SECTION 26 05 48
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This section specifies vibration isolation and seismic restraints for all electrical building systems.
- B. The work in this section includes the following:
 - 1. Vibration isolation devices
 - 2. Equipment vibration balance
 - 3. Flexible connectors
 - 4. Seismic restraints
- C. Provide vibration isolation and seismic restraining transformers to prevent the transmission of vibration and mechanically transmitted sound to the building structure and meet applicable codes as indicated on drawings and as specified.
- D. Include adjustments of each mounting system, and the measurement of isolator system performance. Specific mounting arrangements for each item of electrical equipment shall be as described herein, and as specified in other Division 26 Sections. Generator only.

1.2 RELATED SECTIONS

- A. Applicable provisions of the following codes and trade publications shall apply to the work performed under this section and shall be made part of the contract documents.
- B. Relevant codes and trade standards include the following:
 - 1. ISO 2372 and BS 4675 – Mechanical Vibration for Rotating Machinery.
 - 2. ANSI S2.19 – 1989 (R1987) – Mechanical Vibration - Balance Quality Requirements of Rigid Rotors.
 - 3. ANSI S3.29 – Evaluation of Human Exposure to Vibration.
 - 4. ANSI/AMCA Standard 204-96, - Balance Quality and Vibration Levels for Fans.
 - 5. NEBB, – Sound and Vibration in Environmental Systems.
 - 6. NEBB, – Procedural Standards for Measuring Sound and Vibration.
 - 7. ASHRAE Handbook, – HVAC Applications, Chapter 47 – Sound and Vibration Control.
 - 8. ARI Guideline G, – Mechanical Balance of Fans and Blowers.
 - 9. Local and National Building Codes, as applicable, including site-specific seismic restraint/anchoring design parameters as stated in project structural drawings.
 - 10. California Electrical Code (CEC) 2016 Edition
 - 11. California Building Code (CBC) 2016 Edition

1.3 DESIGN CRITERIA

- A. Transformers shall be vibration isolated as specified in this section.
- B. Equipment vibration limits:
 - 1. All equipment shall be statically and dynamically balanced to meet the following vibration limits under all design operating conditions and under support conditions comparable to the conditions specified in the equipment vibration isolation schedule, at the end of this section.

Equipment Type	Vibration Limit inches/sec, RMS
Fans - direct drive	0.025
Fans – belt drive	0.1
All other rotating equipment	0.1
Reciprocating equipment	0.54
Transformers	0.002

- 2. These vibration limits apply to the three orthogonal axes on the isolated equipment - either on the bearings or the equipment support structure, whichever applicable - and for frequencies between 2 and 200 Hz, using an FFT frequency resolution of 1Hz.
 - 3. For equipment on inertia bases or with large inertia mass these vibration limits shall be reduced by the ratio equipment weight to total weight of equipment plus inertia mass. Inertia mass refers to non-rotating mass rigidly attached to rotating equipment.
- C. All external vibration isolation and seismic restraint devices specified in this section shall be provided by a single supplier.
- D. All seismic restraint devices specified in this section shall be provided by a single supplier.
- E. When an OSP certification is required by OSHPD, deviations from these specifications will be allowed in strict compliance with the OSP.
- F. All vibration isolation and seismic hardware shall be anchored at all times to the building structure.

1.4 SUBMITTALS

- A. Product Data, Shop Drawings, and Calculations: Drawings and calculations signed and sealed by a Structural Engineer licensed in California for approval by OSHPD. Include the following:
 - 1. Design Drawings: 1/8" or 1/4" to 1'-0" scale drawings showing location and type of anchorage, support, or isolator used, keyed to the design details, and mounting attachments to the structure.
 - 2. Design Calculations: For all selected vibration isolators and seismic/wind restraints and for designing vibration isolation bases that clearly demonstrate compliance with seismic/wind restraint code requirements and provide the minimum specified static deflections at each point of support.

3. Manufacturer's model number for each vibration isolator, the equipment or ductwork or pipeline to which it is to be attached , and the number of isolators to be furnished for each installed system.
4. For steel spring mounts or hangers – free height, deflected height, solid height, isolator loading, and diameter of spring coil.
5. For neoprene isolators – free height, deflected height, and isolator loading.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
7. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
8. Seismic/Wind-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
9. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.
10. Complete descriptions of the products to be supplied, including catalog cuts, data sheets, model numbers, dimensions, specifications and installation instructions for all vibration isolation products.
11. An itemized list of all isolated equipment with detailed schedules showing isolators proposed for each piece of equipment, referencing materials and drawings.
12. The following list includes the required shop drawings that shall be submitted:

- (1) Equipment identification mark.
- (2) Manufacturer's model number for each vibration isolator, the equipment or piping to which it is to be attached, and the number of isolators to be furnished for each installed system.
- (3) Show base construction for equipment; include dimensions, structural member sizes and support point locations.
- (4) For steel spring mounts or hangers - free height, deflected height, solid height, isolator loading, and diameter of spring coil. Generator only.
- (5) SEOR to furnish calculations to demonstrate that specified static deflections for isolators are met and to meet applicable codes including seismic restraining for all equipment and piping.

B. Show methods of support for ceiling suspended isolated equipment.

C. If requested, submit samples of vibration isolation devices to be used for this project. After review and approval, samples will be returned and can be installed at the job site. All costs to supply and return such samples shall be borne by the contractor.

- D. Provide installation instructions, drawings and field supervision to insure proper installation and performance of systems.
- E. Upon completion, submit written certification from proper authority that vibration isolation and seismic restraints are installed correctly and properly adjusted.

1.5 QUALITY ASSURANCE

- A. On-Site Vibration Testing
 - 1. During commissioning vibration testing shall be carried out by the owner, in accordance with Part 1.3 of this section to demonstrate compliance with specified vibration limits for Generators.
 - 2. Equipment found to generate excessive vibration shall be properly adjusted and re-tested until brought into compliance with vibration limits in Part 1.3.
 - 3. If the equipment cannot be made to comply with specified vibration limits, the equipment shall be replaced and the new equipment will be retested until compliance is demonstrated.
 - 4. All vibration testing shall be carried out by an independent test agency provided by the Owner and test reports shall be issued to the project engineer that summarize test results and demonstrate equipment complies with specified limits.
- B. Manufacturers to supply products specified in this section shall have a minimum of 10 years documented relevant experience.
- C. Companies contracted to install products specified in this section shall have a minimum of 10 years documented relevant experience.
- D. Vibration isolators shall have markings or other means of determining actual deflection after installation and adjustments have been completed.
- E. Vibration isolators shall operate within the linear portion of their load versus deflection curves.
- F. Neoprene isolators shall have a shore hardness of 30 to 50, within +/- 5%, after aging for a minimum of 20 days.
- G. Substitution or deviation from the vibration isolation specified in this section shall be acceptable as long as the equipment manufacturer provides written guarantees that specified noise and vibration limits shall be met.
- H. All costs for testing and to remedy noncompliant equipment shall be fully borne by the contractor.

1.6 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall have the following responsibilities:
 - 1. Provide equipment vibration isolation as specified.
 - 2. Provide installation instructions, drawings and field supervision to insure proper installation and performance of systems.
 - 3. Shall be responsible for rebalancing, realigning, other remedial required actions, including replacement of any systems, that are found to produce noise and vibration during commissioning exceeding manufacturer's and project's requirements.

4. Be responsible for all costs associated with remedial work to correct deficient installations or installations that generate undue noise and vibration during commissioning
 5. Contractor is not responsible for any cost associated with remedial work due to design deficiencies.
- B. Existing Conditions:
1. The Contractor shall notify the Owner's Representative of any site conditions, which adversely affect vibration isolation system installation or performance.
 2. Installation shall be suspended until approval is received about adverse site conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified or approved equal.

2.2 VIBRATION ISOLATORS

- A. Available Manufacturers:
1. Amber/Booth Company, Inc.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. Vibration Mountings & Controls/Korfund.
 5. Vibrex/M.W Sausse
 6. California Dynamics
 7. Or Approved Equal
- B. Type NSP - Elastomeric Isolator Pads: Oil- and water-resistant single or double ribbed elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Pads shall be sized, and layered with steel shims where required, to provide the minimum static deflections as specified in the vibration isolation schedule but no less than 0.05 inches 1.25 mm.
 2. Elastomeric pads shall be 30 to 50 durometer. Include neoprene shoulder washers to prevent short-circuiting due to through bolting.
 3. Isolators shall be Mason Type W, SW, NK and HL; Amber Booth Type NR, Kinetics Type NP and NGS, or equal.
- C. Type MN - Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Mounts shall have a minimum static deflection as specified in the vibration isolation schedule.

2. Neoprene shall be 30 to 50 durometer.
 3. All metal surfaces shall be neoprene covered to prevent corrosion and have friction pads both top and bottom.
 4. Bolt holes shall be furnished for those areas where bolting is required. Top and bottom surfaces shall have non-skid ribs.
 5. Isolators shall be Mason Type ND or BR, Amber Booth Type SW, Kinetics Type FDS, or equal.
- D. Type MS - Spring Isolators: Freestanding, steel, open-spring isolators.
1. Housing: Steel with factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - a. Spring isolators shall be freestanding and laterally stable without any housing.
 - b. Mountings shall be hot dipped galvanized for corrosion resistance.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: At least 100 percent of the rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Spring elements shall be selected to provide static deflections as shown on the vibration isolation schedules.
 7. Isolators shall be Mason Type SLF, Amber Booth Type SW, Kinetics Type FDS, or equal.
- E. Type MSL - Restrained Spring Isolators: Freestanding, steel, open-spring isolators with limit stops.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: At least 100 percent of the rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. A minimum clearance of 1/4 inch shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action.
 6. Limit stops shall be out of contact during normal operation.
 7. Isolators shall be Mason Type SLR, Kinetics Type FLS, or equal.
- F. Type HN - Elastomeric Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Isolators shall be Mason Type HD, Amber Booth Type BRD, or equal.
- G. Type HS - Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: At least 100 percent of the rated vertical stiffness.
 5. Overload Capacity: Support 500 percent of rated load, fully compressed, without deformation or failure, and to allow a support rod misalignment through a 30 arc without metal to metal contact or other short circuit.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Isolators shall be Mason Type 30, Kinetics Type SH, or equal.
- H. Type HSL - Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: At least 100 percent of the rated vertical stiffness.
 5. Overload Capacity: Support 500 percent of rated load, fully compressed, without deformation or failure, and to allow a support rod misalignment through a 30 arc without metal to metal contact or other short circuit.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Isolators shall be Mason Type 30N, Kinetics Type SRH, or equal.
- I. Type TR - Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: At least 100 percent of the rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.
 8. Horizontal thrust restraints shall be Mason Type WBI/WBD, or equal.

2.3 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers:
1. B-Line Systems, Inc, OPA-0114.
 2. Mason Industries, Inc, OPA-0349.

3. Tomarco Contractor Specialties, OP-0485.
 4. TOLCO Incorporated
 5. NUSIG/Badger
 6. Gripple
 7. Or Approved equal.
- B. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.
- C. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.
- D. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.
- E. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

2.4 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
 2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

2.5 BOLTS

- A. All exposed-to-weather spring isolators/restraints shall have stainless steel bolts.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install vibration isolation and seismic restraint systems in strict accordance with the manufacturer's written instructions, applicable building codes, and approved submittals.

- B. Floor mounts and resilient hangers of the same type can be used interchangeably as long as they are selected to provide the specified minimum static deflection and meet all product specification requirements.
- C. Flexible connectors shall be used to connect all conduit to isolated equipment, except equipment for which flexible connectors are not permitted by code.
- D. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.
- E. Provide restraints for equipment per applicable code. Design and provide restraints to prevent permanent displacement in any direction caused by lateral motion, overturning, or uplift. Restraint of equipment must not inhibit vibration isolation.
- F. Housed spring mounts shall not be permitted unless specifically approved by the Project Engineer.
- G. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.
- H. All vibration isolators must be sized according to weight, distribution (corner weights to be provided by the Manufacturer), static and dynamic loads to be supported. Isolator ratings should be expressed as static deflection based on the actual load supported.
- I. Replace isolators which do not produce the required deflection, are incorrectly loaded, or do not produce the required isolation as approved and at no extra cost to the Owner.

3.2 INSTALLATION

A. GENERAL

1. Allow 6 inches (150mm) minimum clearance between any vibrating equipment and nearby building structures.
2. The minimum operating clearance under all isolated equipment bases shall be 2 inches (50 mm).
3. Allow 20 inches (500 mm) minimum unobstructed space in the ceiling areas for the installation of vibration isolation hangers.
4. All equipment bases shall be placed in position and supported temporarily by blocks or shims prior to the installation of the equipment isolators.
5. Spring isolators shall be installed after all equipment is installed without changing equipment elevations.
6. All roof-mounted isolators shall either be bolted or welded to the building steel or anchored to the concrete deck for resisting code and design wind loads.
7. Resilient hangers shall be installed as near as possible to the supporting overhead structure. The equipment suspension points shall be located in a rigid and heavy portion of the building structure. Suspension of equipment from lightweight floor slabs is not allowed.
8. Suspension rods shall be attached to rigid members of the equipment structure. When such attachment points do not exist, a heavy steel framework shall be provided to support the equipment with suspension rods attached to this framework.

9. Electrical connections to vibration-isolated equipment shall be made with long lengths of flexible steel conduit or flexible armored cable. These flexible connections shall prevent rigid connections between vibration-isolated equipment and the building structure.
10. All debris shall be removed from beneath the equipment. The contractor shall verify that there are no short circuits of the isolators or the isolation system. The equipment shall be free to move in all directions.
11. After the entire installation is complete and under full operational load, the spring isolators shall be adjusted so that the load is transferred from the blocks to the isolators.
12. Seismic restraining devices shall be properly installed and shall not inhibit the performance of the vibration isolation systems.

B. EQUIPMENT VIBRATION ISOLATION

1. Floor-mounted equipment shall be supported on minimum 4 inch (150mm) thick concrete housekeeping pads, unless approved otherwise by the Project Engineer.
2. Concrete housekeeping pads shall be properly attached to the parent floor and designed to comply with structural requirements.
3. Isolated equipment, including equipment steel or concrete bases, shall be supported off the housekeeping pads.
4. Electrical transformers and switchgear shall not be located inside or adjacent to occupied spaces.
5. Electrical transformers outside of the hospital building footprint do not require vibration isolation.
6. Equipment shall be vibration isolated in accordance with the following equipment vibration isolation schedule.

Equipment	Vibration Isolation		Remarks
	Type	Minimum Static Deflection (inches)	
Transformers less than 100 kVA	MN	0.3	Neoprene isolation
Transformers 100 KVA, or greater	MN	0.5	Neoprene isolation

END OF SECTION

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Nameplates and labels
 - 2. Wire and cable identification
 - 3. Conduit color coding
 - 4. Junction box identification
 - 5. Panelboard Directories.
 - 6. Warning and caution signs
 - 7. Device coverplates

- B. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 SUBMITTALS

- A. Submit in accordance with the requirements of Section 26 00 10— BASIC ELECTRICAL REQUIREMENTS and under provisions of Division 01 — SUBMITTALS.
 - 1. Data/catalog cuts for each product and component specified herein.
 - 2. Submit a nameplate schedule to the Architect for review before the nameplates are installed.
 - 3. Submit samples of each color, lettering style and other graphics for identification materials

1.3 QUALITY ASSURANCE

- A. Provide new material supplied by a manufacturer producing identification systems.

- B. Comply with OSHA, and CEC identification requirements for electrical systems.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Type NP engraved, plastic-laminated labels, signs, and instruction plates: Engraved melamine plastic laminate 1/16-inch minimum thickness for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Furnish nameplates with pre-punched mechanical fastener mounting holes.

- B. Color and letter height as specified in part 3, Execution

2.2 LEGEND PLATES

- A. Type LP: Die-stamped metal legend plate with mounting hole and positioning key for motor control pilot devices, etc..
- B. Fill engraved characters, using black paint.

2.3 WIRE AND TERMINAL MARKERS

- A. Self-adhering, pre-printed, self-laminating vinyl wrap-around strips.
- B. Thomas & Betts WSL, Brady B191 series, or equal.

2.4 BRASS TAGS

- A. Metal tags with die-stamped legend punched for fastener. Dimensions: 2-inch diameter, 19 gauge.

2.5 INSCRIBED DEVICE COVERPLATES

- A. Methods of Inscription: (Unless otherwise noted)
 - 1. See 3.10
- B. Embossed metallic or plastic tape is not acceptable for any application.

2.6 UNDERGROUND CONDUIT MARKERS

- A. 6inch wide, 4 mm yellow polyethylene tape, with continuous black imprinting reading "Buried Electric Line" or "Buried High Voltage Line".
- B. Griffolyon "Tera-Tape "Thomas & Betts "WBT Protect-A-Line or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates and labels.
- B. Install nameplates and labels parallel to equipment lines.
- C. Secure nameplates to equipment fronts using screws or rivets. Secure nameplate to inside face of recessed panelboard doors in finished locations.

3.2 WIRE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard gutters at load connection, and at all splice points. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on equipment manufacturers shop drawings for control wiring.
- B. Provide conductor phase color coding as per Section 25 06 19- WIRE AND CABLE.

3.3 NAMEPLATE ENGRAVING

- A. Provide type NP color coded nameplates as applicable, with the following information:
 - 1. Equipment or device designation.
 - 2. Amperage, KVA or horsepower rating, where applicable.
 - 3. Voltage or signal system name.
 - 4. "Served from" identification.
 - 5. Miscellaneous information as shown in "Examples"
 - 6. Examples:
 - a. Panelboards: 2EH1
225A
277/480V, 3PH, 4W
Served From: 2EHD1
 - b. Transformers: ETX-1
150KVA
480V – 120/208V, 3PH, 4W
Served From: EHD1
Load Served: EL1
 - c. Motor Control Centers:
Main Nameplate: Each Compartment
MCC-NH1, EF-1
600A Main Bus, 20 HP
480V, 3PH, 3W, - Switch Size: 100A
Served From: HDD1A-2, Starter Size: 1
 - d. Disconnects or Individual Motor Starters:
EF-1
20PH
480V, 3PH, 3W
Served From: MCCNH-1
 - e. Signal:
STB-3
Public Address System
Served From: STBM
 - 7. Additional tags for each panel shall read as follows:
 - a. 480/277v
Phase A = Brown

Phase B = Orange

Phase C = Yellow

Neutral = Gray

b. 120/208v

Phase A = Black

Phase B = Red

Phase C = Blue

Neutral = White

B. Nameplates for power system distribution equipment and devices are to be colored as follows:
(Unless otherwise noted)

1. Medium Voltage Normal - Black with white letters
2. Medium Voltage Emergency - Red with white letters
3. 277/480 VAC Normal - Black with white letters
4. 277/480 VAC Emergency/Battery - Red with white letters
5. 120/208 VAC Normal - Black with white letters
6. 120/208 VAC Emergency/Battery - Red with white letters

C. Nameplates for signal systems equipment and devices are to be black except as follows:

1. Fire alarm and life safety - White with red letters
2. Clock, Intercom, sound: Magenta with white letters
3. Building management system (BMS): White with black letters
4. Nurse call: Marlin or light blue with white letters

D. Provide nameplates of minimum letter height as noted below:

1. Panelboards, Switchboards and Motor Control Centers: 1/2-inch to identify equipment designation. 1/4-inch to identify voltage rating and source, etc.
2. Individual Circuit Breakers, Switches and Motor Starters in Panelboards, Switchboards, and Motor Control Centers: 3/8-inch to identify load served, and 1/8-inch letters to identify all others.
3. Individual Circuit Breakers, Enclosed Switches, and Motor Starters: 3/8-inch to identify load served, 1/8-inch letters to identify all others.
4. Transformers: 1/2-inch to identify equipment designation. 1/4-inch to identify primary and secondary voltages, primary source, and secondary load and location.
5. Equipment Cabinets, Terminal Cabinets, Control Panels and other Cabinets enclosing apparatus: 3/8-inch to identify equipment and designation.

E. Provide type "LP" metal legend plates for attachment to panel mounted operators devices such as pilot lights, push buttons, selector switches, etc.

3.4 BRASS TAGS

- A. Provide brass tags for individual ground conductors to exposed ground bus indicating connection. For example: "Ufer", "Cold water bond".
- B. Provide tags for all feeder cables in underground vaults and pull boxes.

- C. Provide tags for empty conduits in underground vault, pull boxes, and stubs.

3.5 CONDUIT COLOR CODING SCHEDULE

- A. Primary Medium Voltage Distribution System: Provide yellow background with letters to be black stating 12kv-medium voltage system 25 feet.

3.6 PANELBOARD DIRECTORIES: (400 AMPERE OR LESS)

- A. Provide typewritten directories arranged in numerical order showing number of room in which each device served by each panelboard circuit is located. Identify type of load or equipment served. EEOR to provide update panel schedules to match permit drawings that identify type of load and equipment served.
- B. Verify room numbers to be used with Owner. Room number will not necessarily be those used on the Drawings.
- C. Mount directories in a 6 inch by 8 inch metal frame under a clear plastic cover inside each panelboard door.

3.7 WIRE AND CABLE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard gutters and at load connection. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on equipment manufacturers shop drawings for control wiring.
- B. Provide colored phase markers for color coding noted in Section 26 05 19- LOW VOLTAGE ELECTRICAL CONDUCTORS AND CABLES. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 3 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Do not cover cable identification markers by taping.

3.8 JUNCTION BOX IDENTIFICATION

- A. Paint junction, pull and connection box covers, located above suspended ceiling and below ceilings in non-public areas, using the color coding listed below.
- B. Use finish paint suitable for use on metal surfaces. Provide spray paint that complies with local VOC (Volatile Organic Compound) regulations. Acceptable paint manufacturers; OneShot, Sem or equal.
- C. Legibly mark the painted covers using black permanent ink felt pen, Sharpie or equal; identify circuit(s) contained in the box by circuit number(s) and panel designation.
- D. Color Coding
 1. Normal 277/480 volt, systems: unpainted.
 2. Emergency 277/480 volt, systems: unpainted.
 3. Normal 120/208 volt, systems: unpainted.
 4. Emergency 120/208 volt, systems: unpainted.

5. life safety systems: red.

3.9 WARNING, CAUTION AND INSTRUCTION SIGNS

- A. Provide warning, caution, or instruction signs where required by OSHA, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect
 1. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.
 2. Provide polyester film (PPS) self-adhesive signs for indoor/outdoor equipment and door warning. Use rigid polyethylene (PRS) non-adhesive signs where adhesives will not work; for example, installing on a fence. Provide sign color and marking that meets OSHA regulations. For example, DANGER (red with white letters), HIGH VOLTAGE (white with black letters).
 - a. Use 2 by 4 inch signs for small equipment or enclosure doors.
 - b. Use 7 by 10 inch or 10 by 14 inch signs for large equipment or enclosure doors.
- B. Emergency Operating Signs: Install engraved laminate signs with white letters on red background with minimum 3/8 inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

3.10 INSCRIBED DEVICE COVERPLATE

- A. General
 1. Lettering Type: Helvetica, 12 point or 1/8 inch high.
 2. Color of characters shall be black.
 3. Locate the top of the inscription 1/2 inch below the top edge of the coverplate.
 4. Install so the inscription is centered and square with coverplate.
 5. Provide inscribed coverplates or coverplates as noted on the Drawings or in the Specifications for receptacles, switches, outlet, plugmold, etc.
 6. Provide inscribed coverplates or coverplates for switches, dimmers, etc. as follows:
 - a. All multi-ganged (four or more) switch plates.
 - b. All special purpose switch, for example - fan, projector screen, etc. where it is not obvious what it controls.
 - c. Inscription shall indicate fixtures or devices controlled when there are multiple switches. (For example "Down Lights", "Cove Lights".)
 7. Provide inscribed coverplates or coverplates for all receptacles with panel circuit number (For example "HA116").
 8. Label multioutlet assembly receptacles with panel and circuit number.
- B. Methods of Inscription
 1. All receptacle and switch plate covers shall be either engraved on the plate with a colored circuit label or an engraved plate should be on mounted to the plate using either screws or a glue or adhesive such that the plate cannot be knocked or peeled off without the use of hand tools. Where served by the emergency system, plates shall be red with black letters, otherwise the plate shall be black with white letters or white with black letters.

3.11 RECEPTACLES AND WALL SWITCHES

- A. Write the circuit number on the front side of the device body with permanent black marker (sharpie). Locate so that cover plate conceals number. Use a fine point black permanent marking pen. Identify by noting panelboard and circuit number; for example, "HA1-16".
 - 1. Where served by the emergency system, plates shall be red with black letters, where served by the emergency UPS system plates shall be grey with black letters, otherwise the plate shall be white with black letters.

- B. Conduit Identification
 - 1. Provide identification of equipment served using pressure-sensitive vinyl pipe markers 2-1/4" x 9" on feeder, spare and riser conduit 18-feet on centers in exposed areas, 20-feet on centers above ceilings and upon entering or leaving an area, 80-feet on centers in the crawl space, label each conduit one time in riser runs in a room, for the following:
 - a. 120/208 VOLTS - Orange with black letters.
 - b. 277/480 VOLTS - Orange with black letters.

END OF SECTION

SECTION 26 08 00 ELECTRICAL COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes Division 26 responsibilities in the commissioning process for electrical systems, which are being directed by the CxA.
- B. Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 1. Division 26 shall be familiar with all parts of Division 1 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.3 COMMISSIONING SPECIFICATIONS STATUS

- A. The commissioning specifications are by necessity produced before the commissioning plan is complete. As such, the specifications are intended to establish a level of expectation regarding the types of testing and level of effort to be anticipated during the commissioning process. The CxA and the final commissioning plan including the final functional test scripts will be coordinated with actual equipment, details, sequences of operation, etc. of define the specifics of the electrical systems commissioning.

1.4 SYSTEMS SUMMARY

- A. This Section describes the requirements for start-up and commissioning for Divisions 26 installed work, including the following systems:
 - 1. Low voltage (0-600V) distribution systems (Grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
- B. Refer to the individual specification sections for specific commission requirements for those systems.

RESPONSIBILITIES

- A. Electrical Contractors. The commissioning responsibilities applicable to the electrical contractor are as follows (all references apply to commissioned equipment only):
 - 1. Construction and Acceptance Phases
 - a. Include the cost of commissioning in the contract price, if not yet let.

- b. In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
- c. Attend a commissioning scoping meeting and other necessary meetings scheduled by the C&A to facilitate the C&A process.
- d. Contractors shall provide cut sheets and shop drawing submittals to the C&A of commissioned equipment.
- e. Provide additional requested documentation, prior to normal O&M manual submittals, to the C&A for development of start-up and functional testing procedures.
 - 1) Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.
 - 2) The Commissioning Agent may request further documentation necessary for the commissioning process.
 - 3) This data request may be made prior to normal submittals.
- f. Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the C&A for review and approval.
- g. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- h. Provide limited assistance to the C&A in preparation of the specific functional performance test procedures specified in Section 26 99 50 and the Commissioning Plan. Contractor shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- i. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists from the C&A. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to C&A for review.
- j. During the startup and initial checkout process, execute and document the electrical-related portions of the prefunctional checklists provided by the C&A for all commissioned equipment.
- k. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the C&A.
- l. Address current A/E punch list items before functional testing.

- m. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- n. Perform functional performance testing under the direction of the C&A for specified equipment in Section 26 99 50 and 01 91 13. Assist the C&A in interpreting the monitoring data, as necessary.
- o. Correct deficiencies (differences between specified and observed performance) as interpreted by the C&A, CM and A/E and retest the equipment.
- p. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- q. During construction, maintain as-built red-line drawings for all drawings and provide final record drawings for all owner and contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing).
- r. Provide training of the Owner's operating personnel as specified.
- s. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

1.5 SUBMITTALS

- A. Completed pre-function checklists.

1.6 COORDINATION

- A. Coordinate with the General Contractor and other trades for the scheduling of the CxA activities based on the completeness of the construction work.
 - 1. Assist the C&A and the General Contractor with the development of the Commissioning Schedule and milestones into the overall construction schedule.
 - 2. Assist the C&A with development of the commissioning scripts for functional testing by providing input on feasibility of the draft test scripts. The C&A will author the scripts.

PART 2 - PRODUCTS

1.1 TEST EQUIPMENT

- A. Division 26 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

PART 3 - EXECUTION

1.1 EXAMINATION

- A. Verify that equipment testing work is complete before starting functional performance of power equipment.

- B. Verify that Operational and Maintenance manuals are complete and been approved by the Architect and the Commissioning Agent before starting functional performance testing.
- C. Inspect equipment and confirm that it is clean and ready for operation. All shipping tags removed, nameplates installed and equipment manuals in place. All equipment shall have been vacuumed to remove any metal shavings and dirt prior to testing.
- D. Pre-functional testing should be completed on all components before functional testing begins.

1.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the Owner and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirement for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

1.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Owner. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the C&A and CM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all prejunctional checklists as soon as possible.

3.07 TRAINING OF OWNER PERSONNEL

- A. The Construction Manager shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

- B. The C&A shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.
- C. Electrical Contractor. The electrical contractor shall have the following training responsibilities:
1. Provide the C&A with a training plan two week before the planned training.
 2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
 3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
 6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 7. Training shall include:
 - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discuss relevant health and safety issues and concerns.
 - d. Discuss warranties and guarantees.
 - e. Cover common troubleshooting problems and solutions.
 - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discuss any peculiarities of equipment installation or operation.

8. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance of all pieces of equipment.
9. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
10. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's Representative.

END OF SECTION

SECTION 26 09 14 ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metering in panel boards, switchgear and substations.
- B. Instrument transformers.

1.2 RELATED WORK

- A. Section 26 11 16 SECONDARY UNIT SUBSTATIONS.

1.3 REFERENCES

- A. ANSI C12 - Code for Electricity Metering.
- B. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments
- C. ANSI C57.13 - Requirements for Instrument Transformers.
- D. NECA - Standard of Installation.
- E. California Electrical Code (CEC) 2016 Edition
- F. California Building Code (CBC) 2016 Edition

1.4 SUBMITTALS

- A. Submit product data and shop drawings per Division 01 - SUBMITTALS.
- B. Product Data: provide electrical ratings, adjustment ranges, enclosure type, outline dimensions, and terminal connection information.
- C. Submit manufacturer's instructions per Division 01 - SUBMITTALS.
- D. System description including an overview of the system provided with detailed description of system architecture. System diagram showing location of instrumentation and other assemblies/devices to be connected to the system as well as types of wiring required (electrical and communications), and a general layout of wiring referencing the specific building/facility layout shall also be part of this description.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 01.

1.6 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. and suitable for purpose specified and indicated.

PART 2 - PRODUCTS

2.1 AMMETERS AND VOLTMETERS

- A. Manufacturers:
 - 1. Yokogawa
 - 2. Allen Bradley
 - 3. Crompton
 - 4. GE Industrials
 - 5. Substitutions: Under provisions of Division 01 – PRODUCT OPTIONS AND SUBSTITUTIONS.
- B. Ammeters: ANSI C39.1; direct-reading, full range, indicating ammeter with 4.5 inch (115 mm) square recessed case and 250 degree scale, white dial with black figures and pointer, 5 ampere, 60 Hertz movement, 1 percent accuracy.
- C. Voltmeters: ANSI C39.1; direct-reading, full range, indicating voltmeter with 4.5 inch (115mm) square recessed case and 250 degree scale, white dial with black figures and pointer, 120 volt, 60 movement, 1 percent accuracy.

2.2 CIRCUIT BREAKER COMMUNICATION

- A. Manufacturers
 - 1. Square D
 - 2. Eaton
- B. Circuit breakers shall be factory wired to communicate to communicate via gateway to existing Schneider Electric SCADA system. Provide the following functions to the switchboard meter from each breaker:
 - 1. Current, 3-phase average RMS.
 - 2. Summary alarm.

- C. The gateway for trip-unit communications shall be connected via Cat 5 cable to SCADA network. See network drawing page E601.
- D. Provide all necessary field programming to add circuit breaker trip-units to existing Schneider Electric SCADA power monitoring system including data logging, alarms and update to existing graphic interface.

2.3 ELECTRONIC POWER MONITORS

Unit Substation Main Meter

- A. Manufacturers:
 - 1. Schneider Electric, Model ION 7650
- B. Instantaneous value readouts:
 - 1. Frequency
 - 2. Current, per phase RMS
 - 3. Current, 3-phase average RMS
 - 4. Current, apparent RMS
 - 5. Voltage, phase-to-phase and phase-to-neutral
 - 6. Power factor, per phase
 - 7. Power factor, 3-phase total
 - 8. Real power, 3-phase total
 - 9. Reactive power, 3-phase total
 - 10. Apparent power, 3-phase total
- C. Demand value readouts:
 - 1. Average demand current, per phase
 - 2. Peak demand current, per phase
 - 3. Average demand, real power
 - 4. Predicted demand, real power
 - 5. Peak demand, real power
- D. Energy value readouts:
 - 1. Accumulated energy
 - 2. Accumulated reactive energy
- E. Provide true RMS measurements accurate to 0.2 percent voltage and current sensing.
- F. Connect PTs, meter voltage input, and control power through finger save pull-out fuse holders with 2A class CC fuses, Bussman or equal. Connect current transformers through sharing type test switch disconnects.
- G. Non-volatile time stamps with on-board logging of I/O conditions, minimum/maximum values, energy and demand, maintenance data, alarms, and any measured parameters; trending and short-term forecasting of energy and demand

- H. Provide 6 digit (minimum) LED or LCD display.
- I. Field programmable. Stored data protected from accidental erasing.
- J. Provide KYZ pulse initiator.
- K. Provide multi-port serial and Ethernet communications with at least two Modbus serial ports and one Ethernet port with Ethernet-to-serial RS-485 gateway
- L. Provide 5 - 60 minute programmable demand interval.
- M. Simultaneously waveform capture of voltage and current channels for sub-cycle disturbance, transients, as well as multi-cycle sags, swells and outages in quick succession, without dead time between recordings.
- N. The meter shall permit the user to define a password for security protection. The meter set-up and all user defined values/setting shall be accomplished by entering the information into the device via the four key keypad at the front of the faceplate.
- O. The meter shall be factory installed in unit substation.
- P. The meter shall be connected via Cat 5 cable to SCADA network. See network drawing page E601.
- Q. Provide all necessary field programming to add meter to existing Schneider Electric SCADA power monitoring system including data logging, alarms and update to existing graphic interface.

ATS Load Meter

- A. Manufacturers:
 - 1. Schneider Electric, Model PM8000
- B. Instantaneous value readouts:
 - 1. Frequency
 - 2. Current, per phase RMS
 - 3. Current, 3-phase average RMS
 - 4. Current, apparent RMS
 - 5. Voltage, phase-to-phase and phase-to-neutral
 - 6. Power factor, per phase
 - 7. Power factor, 3-phase total
 - 8. Real power, 3-phase total
 - 9. Reactive power, 3-phase total
 - 10. Apparent power, 3-phase total
- C. Demand value readouts:
 - 1. Average demand current, per phase
 - 2. Peak demand current, per phase

3. Average demand, real power
 4. Predicted demand, real power
 5. Peak demand, real power
- D. Energy value readouts:
1. Accumulated energy
 2. Accumulated reactive energy
- E. Provide true RMS measurements accurate to 0.2 percent voltage and current sensing.
- F. Connect PTs, meter voltage input, and control power through finger save pull-out fuse holders with 2A class CC fuses, Bussman or equal. Connect current transformers through shorting type test switch disconnects.
- G. Non-volatile time stamps with on-board logging of I/O conditions, minimum/maximum values, energy and demand, maintenance data, alarms, and any measured parameters; trending and short-term forecasting of energy and demand
- H. Provide 6 digit (minimum) LED or LCD display.
- I. Field programmable. Stored data protected from accidental erasing.
- J. Provide serial RS-485 Modbus and Ethernet Modbus TCP; provide two Ethernet ports to allow wiring from meter to meter as a daisy-chain.
- K. Provide 5 - 60 minute programmable demand interval.
- L. Simultaneously waveform capture of voltage and current channels for sub-cycle disturbance, transients, as well as multi-cycle sags, swells and outages in quick succession, without dead time between recordings.
- M. The meter shall permit the user to define a password for security protection. The meter set-up and all user defined values/setting shall be accomplished by entering the information into the device via the four key keypad at the front of the faceplate.
- N. The meter shall be factory installed in ATS.
- O. The meter shall be connected via Cat 5 cable to SCADA network. See network drawing page E601.
- P. Provide all necessary field programming to add meter to existing Schneider Electric SCADA power monitoring system including data logging, alarms and update to existing graphic interface.

Distribution Panel Sub-meter

- A. Manufacturers:
1. Schneider Electric, Model EM4200 Enercept
- B. Instantaneous value readouts:

1. Frequency
 2. Current, per phase RMS
 3. Current, 3-phase average RMS
 4. Current, apparent RMS
 5. Voltage, phase-to-phase and phase-to-neutral
 6. Power factor, per phase
 7. Power factor, 3-phase total
 8. Real power, 3-phase total
 9. Reactive power, 3-phase total
 10. Apparent power, 3-phase total
- C. Demand value readouts:
1. Average demand, real power
 2. Peak demand, real power
- D. Energy value readouts:
1. Accumulated energy
 2. Accumulated reactive energy
- E. Provide true RMS measurements accurate to 0.2 percent voltage and current sensing.
- F. Interrupt voltage connection with integral fuse holders. Connect current sensors directly to intercept.
- G. Provide serial RS-485 Modbus communication
- H. The meter shall be field installed per project drawings
- I. The meter shall be connected via RS-485 to SCADA network. See network drawing page E601.
- J. Provide all necessary field programming to add meter to existing Schneider Electric SCADA power monitoring system including data logging, alarms and update to existing graphic interface.

2.4 METERING TRANSFORMERS

- A. Manufacturers:
1. General Electric
 2. Schneider Electric
 3. Yokogawa
 4. Crompton
 5. Substitutions: Under provisions of Division 01 – Materials and Equipment.

- B. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- C. Potential Transformers: ANSI C57.13; 120 volt tapped secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and connect devices per manufacturer's instructions and per NECA standards.
- B. Install metering devices as follows:
 - 1. Secondary Unit Substations:
 - a. Power monitor, PTs and CTs on main.
 - b. Utilize circuit breaker trip units on each feeder breaker.
 - c. Provide electrical load characteristic metering for feeder breakers on each normal power main distribution board feeder. Metering must be capable of recording 72 hour history of peak load.
 - 2. Main 12kV service entrance switchboard.
 - 3. At load side of ATS or at main circuit breaker just downstream of ATS.
 - 4. Outgoing circuits on main switchboards
- C. Electronic power monitoring devices shall be capable of integrating to the building management system and existing SCADA system. Power monitoring system shall be furnished complete from their respective manufacturers with all the necessary communication device panels ("black boxes"), on board sensors and alarm contacts to ensure that the building management system has all the required points of connection for monitoring and alarming purposes. Provide necessary electronic hardware and protocol converters as needed.

3.2 MANUFACTURERS FIELD SERVICES

- A. Provide manufacturers field services under provisions of Division 01 - QUALITY CONTROL.
- B. Include services of technician to supervise installation, adjustments, final connections, system programming and testing.
- C. Training
 - 1. The Contractor shall furnish the services of a manufacturer's representative for an appropriate period of time to train the owner's personnel in the operation and programming of the system. The manufacturer's representative shall be factory-trained and shall have a thorough knowledge of the software, hardware and system programming. Training shall include the following at minimum:

- a. Hands-on training of site personnel
- b. Explanation of system operation
- c. Explanation of devices
- d. Explanation of owner's system.

3.3 TESTING

- A. Refer to Section 26 00 80 - TESTING REQUIREMENTS, for system testing requirements.

END OF SECTION

SECTION 26 11 16 SECONDARY UNIT SUBSTATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Primary Equipment Section(s).
 - 2. Substation Transformer – Dry-Type.
 - 3. Secondary Equipment Sections(s).
 - 4. Accessories.
- B. Related work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 SYSTEM DESCRIPTION

- A. Provide secondary unit substation complete from the incoming line terminals to the outgoing line terminals.
- B. The secondary unit substation shall consist of primary equipment, transformer, and secondary equipment as specified below. The manufacturer of the Unit Substation shall furnish and coordinate all major components of the Substations, including incoming primary equipment section(s), transformer and low-voltage section(s) as well as overcurrent protection devices, relays, and metering components.

1.3 RELATED SECTIONS

- A. 26 13 21 – Medium Voltage Loadbreak switches
- B. 26 18 17 – Enclosed Circuit Breakers
- C. 26 09 14 – Electrical Power Monitoring

1.4 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified.
 - 1. ANSI C12.1 Code for Electricity Metering.
 - 2. ANSI C37.20.3 Metal-Enclosed interrupter Switchgear.
 - 3. ANSI C37.20.4 Indoor AC Medium Voltage Switches used in Metal-Enclosed Switchgear.
 - 4. ANSI C37.5 Current and Potential Transformers.

5. ANSI C37.46 Special Power Fuses & Fuse Disconnecting Switches.
6. ANSI C37.90 Relays and Relay Systems Associated with Electrical Power Apparatus.
7. ANSI C39.1 Requirements for Electrical Analog Indicating Instruments.
8. ANSI C57.12.55 Conformance Standard for Transformers, Dry-Type Transformers used in Init Installations, Including Unit Substations.
9. ANSI C57.13 Requirements for Instrument Transformers.
10. IEEE C57.12.01 General Requirements for Dry-Type Distribution and Power Transformers including those with Solid Cast and/or Resin-Encapsulated Windings.
11. IEEE C57.12.91 Test Code for Dry-Type Distribution and Power Transformers.
12. IEEE C57.94 Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers.
13. IEEE 241 Recommended Practices for Electric Power Systems in Commercial Buildings.
14. IEEE 48 Test Procedures and Requirements for High-Voltage AC Cable Terminations.
15. NEMA AB 1 Molded Case Circuit Breakers.
16. NEMA PB 2 Dead front Distribution Switchboards.
17. NEMA PB 2.1 Proper Handling, Installation, Operation, and Maintenance of Dead front Distribution Switchboards Rated 600 Volts or Less.
18. NEMA SG-5 Power Switchgear Assemblies.
19. NEMA SG-6 Power Switching Equipment.
20. NEMA ST 20 Dry-Type Transformers for General Applications.
21. NEMA TR 1 Transformer, Regulators, and Reactors.
22. NEMA TR 27 Commercial, Institutional and Industrial Dry-Type Transformers.
23. NEMA CC 1 Electrical Power Connectors for Substations.
24. NEMA 210 Secondary Unit Substations.
25. NEMA 241 Recommended Practices for Electric Power Systems in Commercial Buildings.
26. FS W-F-870 Fuse holder (for plug and enclosed cartridge fuses).
27. FS W-S-865 Enclosed Knife Switch.
28. UL 467 Grounding and Bonding Equipment.
29. UL 489 Molded-Case Circuit Breakers and Circuit Breaker Enclosures.
30. UL 869 Service Equipment.
31. UL 891 Dead-Front Switchboard.
32. UL 943 Ground-Fault Circuit Interrupters.
33. UL 977 Ground-Fault Sensing and Relaying Equipment.
34. NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
35. California Electrical Code (CEC) 2016 Edition
36. California Building Code (CBC) 2016 Edition

1.5 SUBMITTAL

- A. Submit shop drawings and product data under provisions of Division 01 – SUBMITTALS.

- B. Submit in accordance with the requirements of Section 26 00 10 – BASIC ELECTRICAL REQUIREMENTS, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Shop Drawings:
 - a. Front, plan and side elevations with overall dimensions, center of gravity, and weight.
 - b. Conduit entrance locations and requirements.
 - c. Nameplate legend.
 - d. Size and number of bus bars per phase, neutral, and ground.
 - e. Connection and support including weight.
 - f. Instruments and accessories.
 - g. Electrical characteristics including primary and secondary voltages, number of phases, bus ratings, device ratings, interrupting capacity.
 - 3. Submit manufacturers' installation instructions.
 - 4. Complete bill of material listing all components.
 - 5. Factory and field-test reports.
 - 6. Warranty.
- C. Dimensions and configurations of substation(s) shall conform to the space allocated on the Drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that shown on drawings for the Owner's Representative's approval. The contractor shall confirm all required clearances with local codes and standards for any revised room layouts.
- D. Submit specified vibration isolation per Division 26 Vibration and Seismic Controls for Electrical specification.
- E. Submit specified transformer sound levels in accordance with NEMA TR-1.

1.6 PRODUCT RECORD DOCUMENTS

- A. Submit record documents under provisions of Division 01 – SUBSTANTIAL AND FINAL COMPLETION.
- B. Accurately record actual locations of substations and circuit connections.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 01 – SUBSTANTIAL AND FINAL COMPLETION.
- B. Include copy of manufacturers certified drawings in project record documents.
- C. Operation Data: Include operating instructions for manually and electrically opening and closing circuit breakers.
- D. Maintenance Data: Include maintenance instructions for cleaning methods; cleaning materials recommended; instructions for circuit breaker removal, replacement, testing and adjustment, and lubrication.

- E. Include bus tightening intervals and procedures, and overcurrent protective device maintenance procedures.

1.8 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum ten years documented experience.
- B. The entire unit substation shall be of unit construction with all parts designed, manufactured, assembled and tested by a single manufacturer to assure complete and proper coordination between all units.
- C. Provide the services of a qualified testing agency to perform the specified tests. Notify in writing the Inspector and the Owner's Representative ten (10) working days in advance of performance of Work requiring testing. Provide all material required for testing.
- D. Seismic Qualifications: Provide equipment that is designed and constructed in accordance with earthquake regulations of the California Building Code.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and protect products under provisions of Division 01 - PRODUCT OPTIONS AND SUBSTITUTIONS.
- B. Accept products on site in factory shipping splits and inspect for damage.
- C. Protect products from moisture and debris by storing in a clean, dry heated space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units. Provide auxiliary heating in switchgear and transformer sections in accordance with manufacturer's instructions.

1.10 EXTRA MATERIALS

- A. Furnish maintenance materials under provisions of Division 01 - SUBSTANTIAL AND FINAL COMPLETION.
- B. Furnish three of each size and type fuse under provisions of Division 01.
- C. Furnish two each of any special tools or safety apparatus required to operate and maintain the equipment.

1.11 WARRANTY

- A. Main equipment and components offered under this Section shall be covered by 1 year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner. Refer to Division One for a definition of acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Eaton/Cutler-Hammer.

2.2 UNIT SUBSTATION

- A. Description: Secondary unit substation comprising fused air switch primary section, dry-type transformer section, and low voltage switchboard secondary section.
- B. Connections between the primary device and transformer and between the transformer and secondary device shall be flexible bus braid or cabling.
- C. Key interlocking between the primary section and the main circuit breaker(s) in the low voltage distribution section shall be provided to insure that the switch cannot be opened or closed while a load is connected to the transformer.
- D. Configuration: Radial primary type.
- E. The unit substation construction and installation shall meet seismic Zone 4 requirements.

2.3 SERVICE CONDITIONS

- A. Meet requirements for usual service conditions.
 - 1. Maximum Ambient Temperature: 104 degrees F (40 degrees C).
 - 2. Altitude: 200 feet.
 - 3. Load Current Harmonic Factor: 0.05 per unit maximum.
 - 4. Transformer Loading Requirements: 150% overload capability with fan cooling.

2.4 PRIMARY SWITCH RATINGS

- A. Maximum Design Voltage: 15 kV, three phase, 60 Hz.
- B. Voltage and Insulation Levels: Conform to ANSI C37.20.3.
- C. Main Bus Ampacity: 600 amperes, continuous.
- D. Momentary Current Rating: To ANSI C37.20.3.

2.5 TRANSFORMER RATINGS

- A. KVA Capacity: Self-cooled rating as indicated on drawings, with increase in rating to 133% with fan cooling.
- B. Primary Voltage: 12.470 kV, delta connected.

- C. Taps: Standard primary taps, 4 below and 2 above at 2.5 percent increments.
- D. Secondary Voltage: 480/277 volts wye connected.
- E. Impedance: 5.75 percent.
- F. Primary Winding Basic Impulse Level: 95 kV.

2.6 INCOMING SECTION EQUIPMENT

- A. Fused air interrupter switch: ANSI C37.20.3.
- B. Configuration: One incoming line.
- C. System Voltage: 15 kv, three phase, 60 Hz.
- D. Maximum Design Voltage: 15 kv.
- E. Basic Impulse Level: 95 kv.
- F. Continuous Rating: 600 amperes.
- G. Main Bus Ampacity: 600 amperes, continuous.
- H. Short Circuit Rating: refer to drawings.
- I. Fuses: Current limiting, Type E. Provide ampere ratings shown on the drawings.
- J. Construction
 1. Switch mechanism: Quick-make, quick-break stored energy operation. No chains or cables used. Switch blades cannot be teased to any intermediate positions.
 2. Padlocking provisions.
 3. Inspection window.
 4. Full height, fully hinged door with lockable handle
 5. Foot operated door stop.
 6. Grounded metal safety barrier.
 7. Kirk-key interlock-prevent access to fuse compartment with switch in closed position.
 8. Permanent operating handle.
 9. Permanent metal or phenolic nameplate.
 10. Door interlock.

2.7 DRY TYPE TRANSFORMERS

A. General Construction

1. Transformer shall be vacuum pressure impregnated ventilated dry type construction for optimum environmental protection. It shall be designed and manufactured in accordance with ANSI C57.12.01 latest revision.
2. Transformer rating shall be constructed of high-grade, grain oriented, silicon steel laminations, with high magnetic permeability. Magnetic flux density is to be kept well below the saturation point. Core construction shall include with mitered joints to keep core losses, excitation current and noise level at a minimum.
3. Transformer coils shall be impregnated using the VPI process. Coils shall be preheated. Individual windings shall be pressure impregnated with solventless polyester resin such that the resin penetrates and seals the windings. The windings shall be subjected to several cycles of dry vacuum followed by positive pressure of dry air or nitrogen to provide complete impregnation of the coils with no voids or air pockets that can create hot spots or cause corona formation. Windings shall be oven treated to completely cure the resin. After core and coils are assembled, spaced and adjusted, the entire assembly shall be treated with resin and oven baked until resin is fully cured.
4. Core and coil assembly shall be enclosed in mild steel housing suitable for indoor or outdoor installation in accordance with the purchase order instructions.
5. Conditions between the primary device and transformer shall be cable.

B. Ratings

1. Transformers shall be rated as indicated in drawings.
2. The average winding transformer temperature rise shall be 150 degrees C.
3. The transformer primary Basic Impulse Rating shall be 95 KV BIL.
4. Transformers for substations shall be provided with fan cooling equipment and control power for fans provided from a control power transformer in the secondary equipment sized to supply power to the fans.

C. Standard Features

1. A stainless steel diagrammatic nameplate shall be mounted on instruction book holder on transformer enclosure.
2. Provisions shall be provided for lifting and jacking the unit into place.
3. A base suitable for rolling and skidding parallel to centerline shall be provided.
4. A ground pad shall be located on low voltage end of enclosure.
5. Vibration isolation shall be internal and in accordance with the Division 26 Vibration and Seismic Controls for Electrical specification.
6. The unit shall be a 60 hertz design.
7. The insulation system shall be rated 220 degree C.

D. Other Features

1. Windings shall be copper.
2. Transformer primary shall have four 2-1/2 percent full capacity taps, two above and two below rated nominal voltage. No load taps shall be available on internal terminal board located behind removable panels on front of transformer case. Taps shall be for de-energized operation only.

3. Sound level shall not exceed the maximum specified by NEMA TR-1, 1980 for applicable KVA size of dry-type transformer.
4. The temperature rise of primary winding at rated KVA loading shall not exceed maximum rise selected above during operation at 30 degrees C average ambient, which does not exceed 40 degrees C in a 24 hour period.
5. A winding temperature indicator shall be included where fan cooling packages are provided.

2.8 OUTGOING SECTION EQUIPMENT

- A. Description: Switchboard manufactured to NEMA PB 2.
- B. Line and Load Termination: Accessible from the rear only, Nema 2-hole crimp type plugs.
- C. Main Section Devices: Individually fixed mounted, draw-out, and compartmented insulated case circuit breaker. Refer to section 26 28 17 Circuit Breakers.
- D. Distribution Section Devices: Individually fixed mounted or draw out insulated case or molded case circuit breaker. Refer to section 26 28 17 Circuit Breakers.
- E. Bus Material: Copper.
- F. Bus Connections: Bolted, accessible from rear only for maintenance.
- G. Main bus shall be silver plated copper, braced to withstand mechanical forces exerted during a short circuit as indicated on the drawings for duration of 30 cycles.
- H. Main Circuit Breaker: insulated case circuit breaker per Section 26 2817— ENCLOSED CIRCUIT BREAKERS.
- I. Feeder Circuit Breakers:
 1. Provided with 1150 + trip units
 2. Normal Substation: LS ± G
 3. Emergency Substation: LSIA
 4. Emergency unit substation breakers shall have individually adjustable ground fault alarm only
 5. All circuit breakers shall have individual adjustments for short delay pickup and time, and include I²t settings and have adjustable instantaneous pickup.
- J. Interrupting Capacity: Minimum capacity shall be 65,000AIC, unless otherwise indicated.
 1. Final capacity value based on the short circuit study completed under provisions of Section 26 05 73—OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.
 2. Series rating of overcurrent protective devices is not acceptable unless specifically noted on the drawings.
- K. Future provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

- L. Be capable of being welded or bolted to a contractor supplied floor sill.
- M. Access: Fully hinged doors with lockable handle.
- N. Ground Fault Protection
 1. General: A solid-state, zone-interlocked, ground fault protection system shall be provided integral on the main and the feeder device(s). It shall consist of integral phase current sensors, appropriate solid-state relaying equipment to provide the desired ground fault current sensitivity and time-current response characteristics. Provide neutral ground fault current transformer for four wire systems. Provisions shall be made for wiring devices for coordination between the main and the feeder devices.
 2. Device Settings: Adjustable pickup current sensitivity for ground fault currents from 200 amperes to 1200 amperes shall be provided. A calibrated dial shall be provided for setting the current pickup point in the field. Time delay shall be adjustable from 0 to 60 cycles. Settings for individual relays shall be as directed by the short circuit/coordination study specified in Section 26 05 73 — OVERCURRENT PROTECTIVE DEVICE COORDINATION Study. A locking screw shall be provided to retain both adjustments at desired setting.
 3. All overcurrent devices shall be independently time coordinated irrespective of zone interlocking to allow the last downstream level of ground fault devices to be time coordinated, i.e. it shall NOT revert to the lowest time setting.
 4. Provide ground fault protection devices as shown on one line diagram and per CEC 517-17.
 5. Ground Fault protection shall be zone interlocked.
 6. The ground fault arrangement shall be integral with the circuit breaker (not add-on device) and its electronic trip. (LSIGT) Provide Neutral Sensor for lighting and other circuit with neutral loading.
 7. Ground fault indication only on emergency unit substation.
- O. All control wiring to be 14ga with wire markers at each end of the control wiring.
- P. Shall be provided with ARM's Technology and provided with a switchgear panel mounted enable padlockable selector switch and indication via Blue LED pilot light.
- Q. Shall be provided with a (SPD) Surge Protective Device on each unit substation secondary section.

2.9 CUSTOMER METERING AND INSTRUMENTATION

- A. Power Monitor: Provide monitor under the provisions of Section 26 09 14 – ELECTRICAL POWER MONITORING.

2.10 ACCESSORIES

- A. Surge Arresters: Provide Distribution Class, heavy-duty metal oxide type, rated 15 kv; mount in incoming line compartment; GE Tranquell or equivalent.
- B. Safety Nameplate: NEMA 260.
- C. Provide control power transformers, overcurrent devices and associated accessories for 120V unit substation control power requirements. Provide batteries that support tripping, relays, metering indicators.

- D. Instrument Test block: Provide 4-pole voltage test and 4-pole current shorting block provisions. GE Type PK-2 or equivalent.
- E. Auxiliary Contacts: Provide SPDT contacts to indicate primary switch and outgoing main circuit breaker open or closed positions.
- F. Inspection Windows shall be provided and installed in a manner to provide good vision of all bussing, and or connection points where access is denied due to locking mechanisms such as Kirk Key.
- G. Provide Fans and Temperature Controller on medium voltage transformers. The rating of the transformers shall not be based on fan cooling

2.11 FABRICATION

- A. Conform to the requirements of ANSI C57.12.28 and ANSI/IEEE C37.81.
- B. Conform to seismic qualifications, California Building Code Title 24 and the Uniform Building Code.
- C. Construction: Indoor.
- D. Main Bus: Copper.
- E. Provide for incoming feeder in load interrupter cubicle.
- F. Ground Bus: Copper; extend length of switchboard. Ampacity not less than 25 percent of main bus rating.
- G. Bussing Arrangement: A-B-C arrangement, left-to-right, top-to-bottom, front-to-rear, as viewed from the front.
- H. Provide 100 percent rated capacity neutral bus.
- I. Provide main bus throughout switchboard per Section 26 24 13.
- J. Provide accessory fuse block, control devices and wiring as required. Use 14 AWG (minimum) grey switchboard type wire. Terminate conductors using terminal blocks.
- K. Height: Per manufacturer standard, including auxiliary support members on top and bottom.
- L. Access: Access to interior through fully hinged covers and doors with quarter turn spring capture hardware with lockable handle.

2.12 FACTORY FINISHES

- A. Clean surfaces before applying paint.
- B. Apply corrosion-resisting primer to all surfaces.
- C. Apply finish coat of baked enamel paint to 4 mils thick.

- D. Finish Color: Manufacturers standard light grey finish.

2.13 NAMEPLATES

- A. Nameplates and warning signs: Refer to section 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS, for instructions.

2.14 SOURCE QUALITY CONTROL

- A. Provide factory test to IEEE C57.12.91. Include routine tests as defined in IEEE C57.12.1 and the following other tests:
 1. Impedance voltage and load loss.
 2. Dielectric tests.
 3. Audible sound level.
 4. Short circuit capability.
 5. Telephone influence factor (TIF).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 02 – EXISTING CONDITIONS: Verification of existing conditions prior to beginning work.
- B. Thoroughly examine site conditions for acceptance of substation installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Provide a concrete housekeeping pad beneath equipment. Coordinate actual sizes of equipment base with shop drawings and extend pad a minimum of 4 inches in all directions beyond overall dimension of base. Provide reinforcing bars as required structurally within pad to insure proper support of equipment.

3.3 FACTORY TESTING

- A. Each unit substation transformer shall be subjected to routine factory tests specified in National Electric Manufacturers Association (NEMA) Publication TR1-1980. Tests shall be conducted in accordance with the provisions of IEEE C57.12.91, or latest revision thereof. Test data on the following tests shall be submitted to the Owner's Representative. Unless identified otherwise, references in the tests outlined below are to section of "Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems," published by NETA (National Electric Testing Association, Inc.).
 1. Resistance measurements of all windings on the rated voltage connection and the tap extremes.

2. Ration tests on the rated voltage connection and on all tap connections.
3. Polarity and phase relation tests on the rated voltage connection.
4. No load loss at rated voltage on the rated voltage connection.
5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated currents on the rated voltage connection and on the tap extremes.
7. Temperature test data on duplicate units shall be acceptable when performed under conditions specified above certifying that temperature rise of windings as determined by resistance methods does not exceed the rated temperature rise.
8. Low frequency applied potential test.
9. Induced potential test.
10. Zero-sequence impedance test.
11. Standard factory impulse tests on all windings.
12. Audible sound level tests shall be performed in accordance with NEMA TR-1 for the transformers.
 - a. Sound test shall conform to NEMA ratings of 66dB for the transformer size 2000kVA.
 - b. Transformers shall not produce excessive harmonic sounds (120Hz, 240Hz, etc.) that exceed the manufacturer NEMA ratings.
13. Transformer shall not produce vibration velocity level exceeding 2/1 000 inch-per-second at the narrow band-frequency of 30Hz, 60Hz, etc. Vibration velocity levels shall be measured at the base of the unit (skid structure) under the fully loaded electrical condition.

3.4 SEISMIC MOUNTING

- A. Provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed structural engineer.
- B. Install equipment in accordance with the earthquake regulations of the California Code Title 24 and the 2013 IBC.

3.5 INSTALLATION

- A. The Contractor shall install all equipment per the manufacturer's recommendations, applicable requirements of the IEEE C57.94, CEC, in accordance with recognized industry practices and the contract drawings.
- B. Handling, storage, installation and energizing of substation shall be carried out in accordance with latest edition of NEMA Publications PB 2.1.
- C. Substations shall be anchored and braced to withstand seismic forces as required by the electrical equipment anchorage details. Provided per section 26 00 10.
- D. Install substation plumb and level and with each section aligned properly.
- E. Vibration Isolation: The substation transformer(s) shall be internally mounted in accordance with manufacturer's printed instructions. Refer to Section 26 05 48 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL.

- F. All necessary hardware to secure the assembly in place shall be provided by the Contractor.
- G. Provide mounting hardware brackets, bus bar drilling and filler pieces for all unused spaces.
- H. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not be limited to:
 1. Check to ensure that the pad location is level to within .125 inches.
 2. Check to ensure that all bus bars are torque to the manufacturer's recommendations.
 3. Assemble all shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.
 4. Secure assemblies to foundation or floor channels.
 5. Measure and record Megger readings phase-to-phase, phase-to-ground and neutral-to-ground and phase-to-neutral (four-wire systems only).
- I. Bending of high-voltage cables shall be avoided or minimized. All necessary bends shall meet at least the minimum radii specified by the cable manufacturer.
- J. All conduits terminating at substation shall have ground bushings and bonding jumpers installed interconnecting all such conduits and the switch gear.
- K. Visually inspect substation for rust and corrosion if signs of rust and corrosion are present, gear shall be restored to new condition or replaced.
- L. Replace any panel pieces, doors or trims having dents, bends, warps or poor fit that may impede ready access, security or integrity.
- M. Provide permanent identification for each feeder and piece of equipment by means of plastic laminated nameplates. All nameplates shall conform to requirements of Section 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS.
- N. Make electrical connections between equipment sections using connectors furnished by manufacturer.
- O. Tighten and torque buss connections and mechanical fasteners, in accordance with manufacturers' instructions, after placing equipment.
- P. Mark torque bolt heads using red or pint paint. Torque Seal or equivalent.
- Q. Rotation on all switchgears, substations, distribution boards, panelboards etc. shall be clockwise throughout the building except on the secondary side of the last disconnect prior to equipment that requires counterclockwise rotation.

3.6 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 26 00 80.
- B. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and start-up of the equipment specified under this section for a period of five working days. The manufacturer's representative shall provide technical direction and

assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained herein.

- C. The Contractor shall provide six (6) copies of the manufacturer's field start-up report to the Architect.

3.7 FIELD TESTING

- A. Refer to Section 26 00 80 - TESTING REQUIREMENTS, for additional system testing requirements.
- B. Independent Testing: The independent testing agency shall perform all quality control electrical testing, calibration and inspection required herein. Testing agencies objectives shall be to:
 - 1. Assure substation installation conforms to specified requirements and operates within specified tolerances.
 - 2. Field test and inspect to insure operation in accordance with manufacturers recommendations and specifications.
 - 3. Prepare final test report including results, observations, failures, adjustments and remedies.
 - 4. Apply label on substation upon satisfactory completion of tests and results.
 - 5. Verify ratings and settings and make final adjustments to overcurrent protective devices.
- C. Owner's Representative Witnessed Testing: Allow a period of 4 hours per substation for Owner's Representative review and final check. This review shall be done when the substation is de-energized, therefore plan accordingly.
- D. At least three weeks prior to any testing notify the Owner's Representative so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Owner's Representative witnessed test.
- E. Supply a suitable and stable source of electrical power to each test site. The testing agency shall specify the specific power requirements.
- F. Testing of overcurrent protective devices shall be done only after all devices are installed and system is energized.
- G. Prefunctional Testing
 - 1. Provide testing agency with contract documents and manufacturer instructions for installation and testing.
 - 2. Visual and mechanical inspection:
 - a. Inspection for physical damage, defects alignment and fit are to be done by the Electrical Contractor and not the independent testing agency.
 - b. Perform mechanical operational tests in accordance with manufacturer's instructions.
 - c. Compare nameplate information and connections to contract documents.
 - d. Checking tightness of all control and power connections are to be done by the Electrical Contractor and not the independent testing agency.
 - e. Checking that all covers, barriers and doors are secure are to be done by the Electrical Contractor and not the independent testing agency.

- f. Verify that potential transformers and overcurrent protective devices meet specified requirements.
 - g. Check key interlocks for safe operation and proper key distribution.
 - h. Verify appropriate equipment grounding for each section and components.
3. Electrical Testing
- a. Primary: Medium Voltage 15kV Air Switch
 - (1) Tests
 - (a) Perform insulation resistance test on each phase to ground and from each phase to each other phase.
 - (b) Perform A.C. or D.C. overpotential test on each pole to ground and pole to pole.
 - (c) Perform contact resistance tests across each switch blade.
 - (2) Test Values
 - (a) Overpotential test voltages shall be applied in accordance with Table 7.6.1 — ANSI 37.20 c.
 - (b) Contact resistance shall be determined in micro-ohms, any value exceeding 50 micro-ohms, or any values which deviate from adjacent poles or similar switches by more than fifty percent (50%) shall be investigated.
 - b. Transformers
 - (1) Tests
 - (a) Insulation resistance tests shall be performed winding-to-winding and winding to ground. Appropriate guard circuit shall be utilized under all bushings. Test voltage and minimum acceptable values in accordance with NETA Section C1.
 - (b) A dielectric absorption test shall be made winding to winding and winding to ground for ten (10) minutes. The polarization index shall be computed. Test voltage and minimum acceptable values in accordance with NETA Section C2.
 - (c) A turns ratio test shall be performed between windings for all tap positions.
 - (d) Winding resistance tests shall be made for each winding at nominal tap position.
 - (e) Perform special tests and adjustments as suggested by manufacturer for tap changer, fan and controls, and alarm functions.
 - (f) Perform power factor or dissipation factor tests in accordance with the test equipment manufacturer's published data.
 - (g) Verify correct secondary voltage phase-to-phase and phase-to neutral after energization and prior to loading.
 - (2) Test Values
 - (a) The absorption test polarization index shall be above 2.0 unless an extremely high value is obtained at the end of one (1) minute that when doubled will not yield a meaningful value with the available test equipment.
 - (b) A.C. high potential test voltage shall not exceed seventy-five percent (75%) of factory test voltage for one (1) minute duration. Evaluation shall be on go / no-go basis. NEMA standard 20.
 - (c) Power factor test values in excess of three percent (3%) should be investigated.
 - (d) Winding resistance test results shall compare within one percent (1%) of adjacent windings.
 - (e) Turns ratio test results shall not deviate more than one-half of one percent (0.5%) from calculated ratio.
 - c. Secondary: Circuit Breaker – Low Voltage (Insulated Case/Molded Case)
 - (1) Test

- (a) A contact resistance test shall be performed.
 - (b) An insulation resistance test shall be performed at 1000 volts D.C. for one (1) minutes from pole to pole and from each pole to ground and across open contacts of each phase.
 - (c) Ground fault pickup current shall be determined by primary current injection.
 - (d) Long time delay shall be determined by primary injection at three hundred percent (300%) pick up current.
 - (e) Short time pickup and time delay shall be determined by primary injection of current.
 - (f) Instantaneous pickup current shall be determined by primary injection.
 - (g) Trip unit reset characteristics shall be verified.
 - (h) Adjustments shall be made for final settings in accordance with coordination study prescribed settings.
 - (i) Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, close and trip operation, trip-free, and antipump function.
- (2) Test Values
- (a) Contact resistance shall be determined in micro-ohms. Any values exceeding two hundred (200) micro-ohms or any values which deviate from adjacent poles or similar breakers by more than fifty percent (50%) shall be investigated.
 - (b) Insulation resistance shall not be less than fifty (50) megohms.
 - (c) Minimum pickup current, trip times and instantaneous pickup values shall be adjusted to coordination study prescribed settings. Test values shall fall within manufacturers published time-current characteristic tolerance band.
- d. Meters
- (1) Calibrate ammeters and voltmeter at mid-scale.
 - (2) Calibrate digital meters to 0.5 percent and verify meter multipliers.
 - (3) Verify that current transformer and voltage transformer secondary circuits are intact.
 - (4) These tests shall be performed in accordance with NETA and ANSI standards after installation and energizing of the switchboard on which the meters are mounted, and before the final acceptance of the contract.
- H. In the event that the system fails to function properly during the testing, as a result of inadequate pre-testing or preparation, the contractor shall bear all costs incurred by the necessity for retesting including test equipment, transportation, subsistence and the Owner's Representative hourly rate.
- I. Replace at no additional cost to the Owner all devices that are found defective or do not operate within factory specified tolerances.

3.8 FIELD ADJUSTMENTS

- A. Adjust transformer taps to deliver appropriate secondary voltage.
- B. Adjust trip units to provide adequate overcurrent protection and selective tripping with downstream protective devices.

3.9 CLEANING

- A. Comply with requirements of Division 01 – CLEANING.
- B. Prior to energizing of substation the contractor shall thoroughly clean the interior of enclosure of all construction debris, scrap wire, etc. using manufacturers recommended materials and methods.
- C. Upon completion of project prior to final acceptance the contractor shall thoroughly clean both the interior and exterior of substation per manufacturers' methods and materials. Remove paint splatters and other spots, dirt, and debris.
- D. Touch-up paint any marks, blemishes, or other finish damage suffered during installation.

3.10 EQUIPMENT ENERGIZING

- A. Clean and test equipment before energizing.
- B. Maintain locked, clean and dust free premise for energized equipment.

3.11 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide six (6) copies of the manufacturer's representative's certification.

3.12 TRAINING

- A. The Contractor shall provide a training session for the Owner's Representatives for eight hours at a jobsite location determined by the Owner's Representative.
- B. Contractor shall schedule training with a minimum of 14 working days advance notice.
- C. The training session shall be conducted by a manufacturer's qualified representative. The training program shall include instructions on the safe operation, maintenance and testing of equipment with both classroom training and hands-on instruction.

END OF SECTION

SECTION 26 12 16 DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes dry-type, medium-voltage transformers, with primary and secondary bushings within or without air-terminal enclosures.

1.3 REFERENCE STANDARDS

- A. IEEE C37.47 - American National Standard Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses; 2000. (ANSI/IEEE C37.47)
- B. IEEE C57.12.28 - IEEE Standard for Pad-Mounted Equipment -- Enclosure Integrity; 2005.
- C. IEEE C57.12.55 - Conformance Standard for Dry-Type Transformers Used in Unit Installations, Including Unit Substations; 1987 (R 1998).
- D. IEEE C57.12.01 - IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those With Solid Cast and/or Resin-Encapsulated Windings; Institute of Electrical and Electronic Engineers; 2005.
- E. IEEE C57.12.91 - IEEE Test Code for Dry-Type Distribution and Power Transformers; Institute of Electrical and Electronic Engineers; 2001.
- F. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; Institute of Electrical and Electronic Engineers; 2008.
- G. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; Institute of Electrical and Electronic Engineers; 1982 (R2006).
- H. IEEE 386 - IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V; Institute of Electrical and Electronic Engineers; 2006.
- I. NEMA 260 - Safety Labels for Padmounted Switchgear and Transformers Sited in Public Areas; National Electrical Manufacturers Association; 1996 (2004).
- J. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2007.
- K. 2016 California Electrical Code (CEC); Part 3, Title 24, California Code of Regulations.

- L. 2016 California Building Code (CBC); Part 2, Title 24, California Code of Regulations.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For dry-type, medium-voltage transformers.
 - 1. Include plans and elevations showing major components and features.
 - a. Include a plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits.
 - 2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include single-line diagram.
 - 4. Include list of materials.
 - 5. Include nameplate legends.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawing:
 - 1. Location plan, showing heavy equipment or truck access paths for maintenance and replacement.
 - 2. Dimensioned concrete base, outline of transformer, conduit entries, and grounding equipment locations.
 - 3. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways, cabletrays and seismic anchors.
 - 4. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.
- B. Qualification Data: For testing agency.
- C. Seismic Qualification Certificates: For transformer assembly, accessories, and components, from manufacturer.
- D. Product Certificates: For transformers, signed by product manufacturer.
- E. Source quality-control reports.
- F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D
- B. ABB
- C. MGM Transformer
- D. Or equal

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2.
- C. Comply with IEEE C57.12.01.

2.3 PERFORMANCE REQUIREMENTS

- A. Windings Material: Copper.
- B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.
- C. Cooling Systems: Comply with IEEE C57.12.01 for cooling class. Class AA.
- D. Capacity: As shown on plans.
- E. Insulation Class: 220 degree C
- F. Coils Insulation Systems:
 - 1. Primary and secondary coil assemblies shall be manufactured using polyester VPI system.
- G. Winding Connections: Connection of windings and terminal markings shall comply with IEEE C57.12.70.
- H. Efficiency: Comply with 10 CFR 431, Subpart K.

- I. Bushings shall comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.
- J. Tap Changer: External, for de-energized operation.
- K. Enclosure:
 - 1. Provide with provisions for lifting and anchoring frame to concrete pad.
 - 2. With an integral skid-mounting frame, suitable to allow skidding or rolling of transformer in any direction.
 - 3. Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface. Apply finish coat of baked enamel paint to 1.5-2 mils thick.
 - 4. Taps: Two 2-1/2-percent, full-capacity taps above and two 2-1/2-percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.
- L. Sound level shall comply with requirements of NEMA TR 1.
- M. Capacities and Characteristics:
 - 1. Enclosure: Type 1 enclosure.
 - 2. Additional IEEE Standards: Comply with IEEE C57.12.55.
 - 3. Comply with UL 1562 listing requirements.
 - 4. Maximum Ambient Temperature: 104 Degrees F (40 Degrees C)
 - 5. Connections:
 - a. Primary: Direct connection to Primary.
 - b. Secondary: Direct connection to switchboard.
 - 6. Transformer Ratings.
 - a. Impedance: Not less than 5.75 percent.
 - b. Temperature Rise: 150 deg C.
 - c. Coils Connection:
 - 1) High-Voltage Winding: Delta
 - 2) Low-Voltage Winding: Wye
 - d. Voltage and BIL Ratings:
 - 1) Nominal primary phase-to-phase voltage and BIL: 12.47kV, 95 kV.
 - 2) Nominal secondary voltage and BIL: 480Y/277 V, 95 kV.
 - e. Overload rating: 33%
 - 7. Taps: Two 2-1/2-percent, full-capacity taps above and two 2-1/2-percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.51 requirements.

2.4 ACCESSORIES

- A. Accessories: IEEE C57.12.00 standard accessories and IEEE C57.12.01 standard accessories.
- B. Tap Changer: Externally-operated type.

- C. Primary Terminations: Bushing wells to IEEE 386; provide three for radial feed. Include bushings for insulated loadbreak connectors.
- D. Primary Terminations: Porcelain insulator with clamp-type connector.
- E. Primary Switching: Fused air switch, gang operated.
- F. Primary Overcurrent Protection: fuses.
- G. Secondary Terminations: Spade lugs.
- H. Secondary Switching and Overcurrent Protection: Molded case circuit breaker insulated case connect breaker, or Low Voltage power current breaker; UL listed.
- I. Other Accessories: Primary lightning arrestors and secondary current transformers to IEEE C57.13.

2.5 SOURCE QUALITY CONTROL

- A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.91.
- B. Perform the following factory-certified routine tests on each transformer 500 kVA and less for this Project:
 1. Turns ratio, polarity, and phase relation on rated voltage connection.
 2. Transformer no-load losses and excitation current at 100 percent of ratings. This test may be based on a statistical sample.
 3. Applied voltage and induced voltage.
 4. Partial discharge.
 5. Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
 6. Temperature rise at minimum and maximum ratings.
 7. Impulse.
 8. Insulation power factor.
 9. Insulation resistance.
 10. Audible sound level.
 11. Short-circuit capability.
 12. Operation of all devices.
 13. Control (auxiliary) and consumption loss data values.
- C. Perform the following factory-certified tests on each transformer 500 kVA and larger for this Project. Reports shall comply with the minimum information requirements of IEEE C57.12.01:
 1. Resistance measurements of all windings on rated voltage tap and at tap extremes.
 2. Turns ratio, polarity, and phase relation on rated voltage connection.
 3. Transformer no-load losses and excitation current at 100 percent of ratings.
 4. Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
 5. Applied voltage and induced voltage.
 6. Partial discharge.
 7. Leak test.
 8. Temperature rise at minimum and maximum ratings.
 9. Impulse.

10. Insulation power factor.
 11. Insulation resistance.
 12. Audible sound level.
 13. Short-circuit capability.
 14. Operation of all devices.
 15. Control (auxiliary) and consumption loss data values.
- D. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine dry-type, medium-voltage transformers upon delivery.
1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.
 2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
 3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
 4. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
 5. Unload transformers carefully, observing all packing label warnings and handling instructions.
 6. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
- B. Handling:
1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
 2. Protect transformer against entrance of dust, rain, and snow.
 3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and transformer case.
 4. Verify that transformer weights are within rated capacity of handling equipment.
 5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
 6. Use jacks only at corners of base plate of transformer case.
 7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
 8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.

9. Exercise care not to damage base structure of case when handling transformer using skids or rollers. Use skids to distribute stresses over case base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Visually check for rust spots.

D. Examine areas and space conditions for compliance with requirements for dry-type, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine walls, floors, roofs, and concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:

1. Verify removal of any shipping bracing after placement.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.

I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.
- B. Comply with requirements for vibration isolation and seismic control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. For grounding to grounding electrodes, use bare copper cable not smaller than No. 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
 - 2. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.
 - 3. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
 - 2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.
- C. Terminate medium-voltage cables in incoming section of substations according to Section 260513 "Medium-Voltage Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing e factory tests to IEEE C57.12.91 and IEEE C57.12.01. Include the routine tests as defined in the standards and the following other tests:
 - 1. Temperature rise.
- B. Test insulating liquid samples in accordance with IEEE C57.111.
- C. Make completed unit substation available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.
- D. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner at least 7 days before inspections and tests are scheduled.

3.5 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
 - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each transformer. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater

- than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust transformer taps so that secondary voltage is above and within 2 percent of rated voltage.
 - b. Prepare written request for voltage adjustment by electric utility.
 3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
 4. Report:
 - a. Prepare a written report covering monitoring performed and corrective action taken.
- B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove all necessary covers prior to inspection.
1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
 2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.
 3. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists results as follows:
 - a. Description of equipment to be tested.
 - b. Discrepancies.
 - c. Temperature difference between area of concern and reference area.
 - d. Probable cause of temperature difference.
 - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - f. Identify load conditions at time of inspection.
 - g. Provide photographs and thermograms of deficient area.
 4. Act on inspection results according to recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION

SECTION 26 13 21 MEDIUM VOLTAGE LOADBREAK SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Medium voltage load break switches used as components of Medium Voltage unit substation primary switch device.
- B. Medium voltage fuses

1.2 REFERENCES

- A. IEEE 37.20.3 - Metal-Enclosed Interrupter Switchgear
- B. California Electrical Code (CEC) 2016 Edition
- C. California Building Code (CBC) 2016 Edition

1.3 RELATED SECTION

- A. Section 26 11 16— SECONDARY UNIT SUBSTATION

1.4 SUBMITTAL

- A. Comply with provisions of Division 01 - SUBMITTALS.
- B. Shop Drawings: Indicate outline dimensions, enclosure construction, shipping splits, lifting and supporting points, electrical single line diagram, and equipment electrical ratings.
- C. Product Data: Provide data for components and accessories.
- D. Seismic Design: Provide switchboard anchorage details and manufacturers seismic certification.

1.5 PROJECT CLOSEOUT SUBMITTALS

- A. Comply with provisions of Division 01- SUBSTANTIAL AND FINAL COMPLETION:
 - 1. Closeout Procedures for project closeout.
- B. Maintenance Data: Fuse replacement, adjustment and lubrication instructions.

1.6 QUALITY ASSURANCE

- A. Seismic Qualifications: Provide equipment that is designed and constructed in accordance with earthquake regulations of the California Code Title 24 and the Uniform Building Code.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Division 01 – PRODUCT OPTIONS AND SUBSTITUTIONS on instructions for Transportation, handling, storing, and protecting products.
- B. Protect switches from weather and moisture by covering with heavy plastic or canvas and by maintaining heating within enclosure in accordance with manufacturer's instructions.

1.8 EXTRA MATERIALS

- A. Division 01 - SUBSTANTIAL AND FINAL COMPLETION.
- B. Furnish two insulated-handle tools designed for handling medium voltage fuses.
- C. Furnish two each of safety apparatus required to operate and maintain equipment
- D. Furnish two sets (3) of spare fuses of each size and rating.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Eaton/Cutler-Hammer
- B. Square D

2.2 LOAD BREAK SWITCHES

- A. Description: individual air switches in free-standing cubicles, connected to a common bus, securely bolted together to form part of an integrated structure, suitable for installation where accessible by authorized personnel only.
- B. System Voltage: 15 kV, three phase, 60 Hz.
- C. Maximum Design Voltage: 15 kV.
- D. System Grounding: solid.
- E. Basic Impulse Level: 95 kV.
- F. Continuous rating: 600 amperes, continuous.
- G. Short Circuit Rating: 40,000 rms symmetrical amperes at rated nominal voltage, unless otherwise noted on the drawings.
- H. Fault Closing: 40,000 rms symmetrical amperes at rated nominal voltage, unless otherwise noted on the drawings.

I. Construction:

1. Quick make, quick break, three-pole gang operated mechanism with stored energy operation.
2. Operating Mechanism: Manual over-toggle type utilizing heavy duty coil spring to provide opening and closing action of switch. The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to tease the switch into any intermediate position.
3. Operating Handle: Permanently mounted, lockable in both positions, interlocked to prevent opening fuse compartment door with switch in CLOSED position.
4. Auxiliary Contacts: Provide SPDT contacts that indicate switch open or closed positions.
5. Provide separate main and make/break contacts to ensure maximum endurance for fault close and load interrupting duty.
6. Provide glass polyester insulating barriers between phases and between outer phases and enclosure.
7. Cable Terminals: Compression/crimp type suitable for copper cable of number and size indicated on the Drawings.
8. Enclosure:
 - a. High impact viewing window permitting full view of the position of all switch blades though the closed door.
 - b. Fuse access door interlocked with the switch so that:
 - (1) switch must be opened before access to fuses is possible.
 - (2) door must be closed before switch can be closed.
 - (3) blown fuse indicator is visible without opening the door.
 - c. Grounded metal barrier in front of switch to prevent inadvertent contact with live parts yet allow full-view inspection of switch blade position.
 - d. Provision for padlocking of switch in open or closed position.
 - e. Permanent switch position indicators.
9. Ground fault sensor and indicating light.
10. Padlocked hinged doors held close by bolts.
11. Provide without surge arrestors.
12. Bus: Tin Plated Copper.
13. Ground Bus: Silver Plated Copper.

2.3 FACTORY FINISH

- A. Clean surfaces before applying paint.
- B. Apply corrosion-resisting primer to all enclosure surfaces.
- C. Apply finish coat of manufacturers standard baked enamel paint to 4 mils thick.
- D. Finish Color: same as entire assembly.

2.4 MEDIUM VOLTAGE FUSES

- A. Manufacturers:
 1. Cutler-Hammer, Type HLE or CLEPT
 2. Or equal.

- B. Description: Enclosed current limiting, non-expulsion type suitable for use indoors.
- C. Fuse Rating: E rated fuse, size as indicated.
- D. Voltage Class: 15.0 kV.
- E. Interrupting Rating: 100,000 amperes rms symmetrical.

2.5 NAMEPLATES

- A. Nameplates and warning signs: Refer to Section 26 05 53 - ELECTRICAL IDENTIFICATION, for instructions.

2.6 SOURCE QUALITY CONTROL

- A. Provide factory inspection and testing in accordance with IEEE C37.20.3.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 2 – EXISTING CONDITIONS for verification of existing conditions prior to beginning work.
- B. Verify that support pads furnished under Section 03 31 00- CAST-IN-PLACE CONCRETE are ready to receive Products.

3.2 SEISMIC MOUNTING

- A. Provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed structural engineer.
- B. Install equipment in accordance with the earthquake regulations of the California Building Code.

3.3 INSTALLATION

- A. Install plumb and level and with each section aligned properly.
- B. Make electrical connections between equipment sections using connectors furnished by manufacturer.
- C. Tighten and torque buss connections and mechanical fasteners, in accordance with manufacturer's instructions, after placing equipment.
- D. Mark torqued bolt heads using red or pink paint. Torque Seal or equivalent.

3.4 CLEANING

- A. Comply with requirements of Division 01 – CLEANING.
- B. Touch up scratched or marred surfaces to match original finish. All site applied paint shall comply with VOC limits in Division 1.
- C. Thoroughly wipe dirt and dust from devices and components. Vacuum equipment interior after cleaning devices.

3.5 EQUIPMENT ENERGIZING

- A. Clean and test equipment before energizing.
- B. Maintain locked, clean and dust free premise for energized equipment.

3.6 TESTING

- A. Refer to 26 00 80 - TESTING REQUIREMENTS, for system testing requirements.

END OF SECTION

SECTION 26 24 16 PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to branch circuit panelboards. (Below 800 amps).
- B. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. NEMAAB1 - Molded Case Circuit Breakers
 - 2. NEMAPB1 – Panelboards
 - 3. NEMAPB1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
 - 4. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment
 - 5. NECA Standard of Installation
 - 6. California Electrical Code (CEC) 2016 Edition
 - 7. California Building Code (CBC) 2016 Edition

1.3 SUBMITTALS

- A. Submit shop drawings for equipment and component devices under provisions of Division 01 - SUBMITTALS.
- B. Submit in accordance with the requirements of Section 26 00 10- BASIC ELECTRICAL REQUIREMENTS, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Shop Drawings: Include elevations, cabinet dimensions, center of gravity, weight, gutter sizes, layout of contactors, relays, time clocks, lug sizes, bussing diagrams; make, location and capacity of installed equipment; mounting style; finish and panelboard nameplate inscription.
 - 4. Indicate voltage, main bus ampacity, integrated short circuit ampere ratings, circuit breaker arrangement and size.
 - 5. Submit structural calculations for equipment anchorage as described in Section 26 0010- BASIC ELECTRICAL REQUIREMENTS.
 - 6. Submit manufacturer's installation instructions.
 - 7. Complete bill of material listing all components.
 - 8. Warranty.

- C. Dimensions and configurations of panelboards shall conform to the spaces allocated on the Drawings for their installation. The Contractor shall include with the submittal a coordinated layout plan indicating locations of panelboards for review and approval prior to release of order.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Division 01 - SUBSTANTIAL AND FINAL COMPLETION: Submittals for project closeout
- B. Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALITY ASSURANCE

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. and suitable for purpose specified and indicated.

1.6 MAINTENANCE MATERIALS

- A. Division 01- SUBSTANTIAL AND FINAL COMPLETION.
- B. Furnish two of each panelboard key.

1.7 WARRANTY

- A. Units and components offered under this Section shall be covered by 1 year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner. Refer to Division One for the definition of Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURER - PANELBOARDS

- A. Eaton

2.2 DISTRIBUTION PANELBOARDS

- A. Panelboards: NEMA PB 1; circuit breaker type. Any panelboard rated 250A through 600 A shall be considered a distribution panelboard.
- B. Panelboard Bus: Copper, ratings as indicated. Provide copper and neutral ground bus in each panelboard.
- C. Provide cabinet front with screw cover and fully piano hinged doors with flush lock, door in door construction. Finish in manufacturers standard gray enamel. Provide with metal directory holder with heavy clear plastic protector or as defined in section 26 0553- IDENTIFICATION FOR ELECTRICAL SYSTEMS. No EZ Trim covers.
- D. Cabinet Locks: provide flush type cylinder locks and latches, all keyed alike.

- E. Minimum Integrated Short Circuit Rating: 30,000 amperes rms symmetrical for 208 volt panelboards; 42,000 amperes rms symmetrical for 480 volt panelboards, or as shown on Drawings and as defined in section 26 0573 Power System Study results.
- F. Circuit breakers: molded case type per Section 26 28 17— CIRCUIT BREAKERS.
- G. Equip panels with main circuit breaker unless otherwise noted on schedules or the drawings.
- H. Main Lug only type panels shall have a provision for 2 hole incoming compression type connectors.

2.3 BRANCH CIRCUIT PANELBOARDS

- A. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1 circuit breaker type.
- B. Enclosure: NEMA PB 1; Type 1 or 3R as indicated on the drawings.
- C. Cabinet Size: 6 inches deep; 20 inches wide.
- D. Provide flush or surface cabinet front as shown on the Drawings with fully piano hinged and flush lock all keyed alike. Door in door construction. Finish in manufacturers standard gray enamel. Provide metal directory holder inside door with clear plastic protector.
- E. Provide panelboards with copper bus, ratings as scheduled on Drawings. Provide copper ground bus in all panelboards.
- F. Minimum Integrated Short Circuit Rating: 22,000 amperes rms symmetrical for 208 volt panelboards; 25,000 amperes rms symmetrical for 480 volt panelboards or as shown on Drawings and as defined in section 26 0573- OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY results.
- G. Circuit breakers: molded case type per Section 26 2817— ENCLOSED CIRCUIT BREAKERS.
- H. Equip panels with main circuit breakers unless otherwise noted on schedules or the drawings.
- I. Main lug only panels shall have provision for 2 hole incoming compression type connectors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Thoroughly examine site conditions for acceptance of panelboard installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 INSTALLATION

- A. Install panelboards in accordance with manufacturers written instructions, as shown on the drawings, in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Set panels plumb and symmetrical with building lines in conformance with PB1 .1. Furnish and install all construction channel bolts, angles, etc., required to mount the equipment furnished under this Section. Install recessed panelboards flush with wall finishes.

- C. Height: 6 foot and 6 inches to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- D. Provide mounting hardware brackets, busbar drillings and filler pieces for all unused spaces.
- E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- F. Conduits terminating in concentric, eccentric or oversized knockouts at panelboards shall have ground bushings and bonding jumpers installed interconnecting all such conduits and the panelboard.
- G. "Train" interior wiring; bundle and clamp, using specified plastic wire wraps specified under Section 26 0519: WIRE AND CABLE.
- H. Ground and bond all panelboard enclosures according to Section 26 0526- GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS. Bond panelboard ground bus bars per CEC 517.14.
- I. In damp and wet locations mount panelboards with a minimum one inch of air space between cabinet and the wall or other supporting material.
- J. All surfaces of surface mounting cabinets and fronts shall be given one coat of metal primer and a finish coat of baked on gray enamel.
- K. Panelboards located in mechanical areas shall have weatherproof gaskets on trims and doors.
- L. Provide close up plugs in all unused openings in the cabinet.
- M. Circuit breakers feeding Fire Alarm Control Panel(s)" shall be red in color and shall have handle locks.
- N. Provide nameplates under the provisions of Section 26 0553— IDENTIFICATION OF ELECTRICAL SYSTEMS.
- O. Provide neutral bus to accommodate dedicated neutrals for all current carrying conductors per 2013 CEC.
- P. Switchboards rigidly attached to externally vibration isolated transformers shall also be isolated per the Division 26 Vibration and Seismic Controls for Electrical specification.
- Q. Rotation on all switchgears, substations, distribution boards, panelboards etc. shall be clockwise throughout the building except on the secondary side of the last disconnect prior to equipment that requires counterclockwise rotation.

3.3 SEISMIC MOUNTING

- A. Install equipment in accordance with the earthquake regulations of the California Building Code.
- B. Panelboards shall be anchored and braced to withstand seismic forces as required by the electrical equipment anchorage details.

3.4 ADJUSTING

- A. Measure steady state load currents at each panelboard feeder; notify engineer of record when phase loads are not within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- B. Check and tighten all bolts and connections with a torque wrench using manufacturers recommended values.

3.5 CLEANING

- A. Comply with requirements of Division 01 - CLEANING.
- B. Prior to energizing of panelboards the contractor shall thoroughly clean the interior of enclosure of all construction debris, scrap wire, etc. using manufacturers methods and materials.
- C. Upon completion of project prior to final acceptance the contractor shall thoroughly clean both the interior and exterior of panelboards per manufacturers recommended materials and methods. Remove paint splatters and other spots, dirt, and debris.
- D. Touch-up paint any marks, blemishes, or other finish damage suffered during installation.
- E. Visually inspect panelboard for rust and corrosion. If signs of rust and corrosion are present, restore or replace panelboard to new condition.

3.6 EQUIPMENT ENERGIZING

- A. Clean and test equipment before energizing.
- B. Maintain locked, clean and dust free premise for energized equipment.

3.7 TESTING

- A. Refer to Section 26 00 10— BASIC ELECTRICAL REQUIREMENTS and 26 00 80 - TESTING REQUIREMENTS, for system testing requirements.

END OF SECTION

SECTION 26 27 26 WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Wall switches
 - 2. Receptacles
 - 3. Coverplates
 - 4. Wall Dimmers
- B. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified.
 - 1. NEMA WD - 1 - General Purpose Wiring Devices
 - 2. NEMA WD - 2 - Semiconductor Dimmers for Incandescent Lamps
 - 3. NEMA WD - 5 - Specific—Purpose Wiring Devices
 - 4. NEMA WD - 6 - Wiring Device Configurations
 - 5. California Electrical Code (CEC) 2016 Edition
 - 6. California Building Code (CBC) 2016 Edition

1.3 SUBMITTALS

- A. Submit in accordance with the requirements of Section 26 00 10— Basic Electrical Requirements and under provisions of Division 01 - SUBMITTALS.
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 3. Provide color finishes for Architect to select from.
 - 4. Submit manufacturer's installation instructions.
 - 5. Submit one sample of each type of device and cover plate.
 - 6. Where engraved device coverplates are noted on the drawings or in the specifications, conform to the requirements of Section 26 05 53— IDENTIFICATION FOR ELECTRICAL SYSTEMS.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years documented experience.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All devices shall conform to National Electrical Manufacturers Association (NEMA) standards and shall be Underwriters Laboratories, Inc., (UL) listed and labeled and shall be "Specification Grade," Industrial/heavy-duty type, meeting the requirements of Federal Specification WC-596-F for receptacle, and meeting the requirements of Federal Specification WS-896-E, for switches. All devices for use in hospital patient care area shall be "Hospital Grade."
- B. Color
 - 1. Devices on normal power (non-essential power) shall be white.
 - 2. Devices on emergency power shall be red.
 - 3. Devices on isolated ground power shall be orange.
- C. All devices shall be of the same manufacturer, where applicable.

2.2 SWITCHES

- A. Description: NEMA WD 1, heavy-duty, AC only general-use, quiet type snap switch with fast make-slow break, silver-cadmium oxide alloy contacts, side and back wired.
- B. Device Body: White plastic with matching toggle handle, except that switches serving emergency loads shall be red.
- C. Illuminated Handle Type Switch: Clear color handle.
- D. Pilot Light: lighted handle type switch, red color handle.
- E. Voltage Rating: 120-277 volts, A.C.
- F. Current Rating: 20 amperes.
- G. Rocker switch type must be architecturally styled smooth action, concave rocker. It shall be molded from impact resistant thermoplastic, with a wrap around heavy gage strap and utilize back and side wiring.
- H. Manufacturers and Model Numbers:
 - 1. Single-pole switch:
 - a. Hubbell No. HBL-1221
 - b. Arrow Hart/Cooper #2211
 - c. P&S
 - d. Leviton
 - e. Or equal.
 - 2. Double-pole switch:
 - a. Hubbell No. HBL-1222
 - b. Arrow Hart/Cooper #2222
 - c. P&S
 - d. Leviton
 - e. Or equal.
 - 3. Three-way switch:
 - a. Hubbell No. HBL-1223

- b. Arrow Hart/Cooper #2223
 - c. P&S
 - d. Leviton
 - e. Or equal.
4. Four-way switch:
- a. Hubbell No. HBL-1224
 - b. Arrow Hart/Cooper #2224
 - c. P&S
 - d. Leviton
 - e. Or equal.
5. Pilot light handle indicator switch with clear handle:
- a. Hubbell No. HBL-1221-PL for 120V
 - b. Arrow Hart/Cooper
 - c. P&S
 - d. Leviton
 - e. Or equal.
6. Illuminated handle - Locator switch with white handle:
- a. Hubbell No. HBL-1221-ILC
 - b. Arrow Hart/Cooper
 - c. P&S
 - d. Leviton
 - e. Or equal.
7. Up-down control switch: 3-position, center off, momentary contact:
- a. Hubbell No. HBL-1557
 - b. Arrow Hart/Cooper
 - c. P&S
 - d. Leviton
 - e. Or equal.

2.3 FLUORESCENT AND LED WALL DIMMERS

- A. Manufacturers
 - 1. Lutron
 - 2. Or approved equal. Submit substitutes to Electrical Engineer for review.
- B. Description: NEMA WD 1; Semiconductor dimmer for fluorescent lamps, type as indicated on Drawings.
- C. Device Body: Plastic with linear slide, color as selected by Architect.
- D. Voltage: As required by electrical lighting plans.
- E. Power Rating: Match load shown on Drawings, 1000 watts minimum.
- F. Accessory Wall Switch: Match dimmer appearance.
- G. Coordinate specific dimmer required by source and load as circuited on electrical lighting plans.

2.4 RECEPTACLES

- A. Description: NEMA WD1, heavy duty, specification grade receptacles.
- B. Device Body: Color shall match switches; emergency receptacles shall be red.
- C. Configuration: NEMA WD6, type as specified and indicated.
- D. Convenience Receptacle: Type 5-20R, specification grade, or hospital grade as required by these specifications and CEC.
- E. Special Receptacle: NEMA type as indicated. Hospital grade in corridors and in patient bed locations. Provide tamper-proof devices at all waiting areas and lobbies. Provide tamper-proof receptacle in pediatric care areas per CEC article 517.
- F. Construction:
 - 1. Nylon housing.
 - 2. One-piece yoke and ground contact (except isolated ground type) made of heavy gage brass.
 - 3. Brass contacts.
 - 4. Solid Center rivet.
 - 5. Back and side wiring type.
 - 6. Leviton "Lev Lok" quick connect device also acceptable for specification and hospital grade 5-20R devices.
- G. Manufacturers and Model Number:
 - 1. Hospital grade convenience receptacle:
 - a. Hubbell No. 8300
 - b. Arrow Hart/Cooper
 - c. P&S plug Tail Products
 - d. Leviton
 - e. Leviton "Lev Lok" quick connect receptacle device also acceptable for both specification grade and hospital grade devices
 - 2. Hospital grade GFCI receptacle:
 - a. Hubbell No. GF-8300
 - b. Arrow Hart/Cooper
 - c. P&S plug Tail Products
 - d. Leviton
 - e. Or equal.
 - 3. Hospital grade tamper resistant receptacle:
 - a. Hubbell No. HBLSG63H
 - b. Arrow Hart/Cooper
 - c. P&S plug Tail Products
 - d. Or equal.
 - 4. Hospital grade isolated ground convenience receptacle:
 - a. Hubbell No. IG-8300
 - b. Arrow Hart/Cooper
 - c. P&S plug Tail Products
 - d. Or equal.
 - 5. Special receptacle:
 - a. Type as identified by NEMA standard number on drawings.

2.5 WALL PLATES

- A. Provide smooth, stainless steel plates, American Iron and Steel Institute (AISI) Type 302, QQ4Q thick with satin smooth finish. Provide in all mechanical, central sterile, Engineering and Maintenance work area and kitchen areas. Color as selected by Architect.
1. Hubbell No. S Series.
 2. Arrow Hart/Cooper.
 3. GE.
 4. Leviton
 5. P&S plug Tail Products
 6. Or equal.
- B. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device cover.
1. Hubbell No. CWP8H.
 2. Arrow Hart/Cooper
 3. GE.
 4. Leviton
 5. P&S plug Tail Products
 6. Or equal.
- C. Thermo plastic/nylon UL listed, FSUL514 nylon wall plate with matching metal mounting screws. Resistant to impact, abrasion, oils, acids, moisture, fading and discoloration. Provide in all areas not listed for stainless steel or galvanized steel, U.O.N. Color as selected by Architect.
1. Hubbell.
 2. Arrow Hart/Cooper
 3. GE.
 4. Leviton
 5. P&S plug Tail Products
 6. Or equal.
- D. Provide common coverplate for ganged devices where they are side by side.
- E. Provide code required barrier.

2.6 FLOOR MOUNTED SERVICE FITTINGS

- A. Pedestal Fitting:
1. Hubbell Model SC-3091 series.
 2. Steel City Model SFH-40 series.
 3. Walker Model 500 series.
 4. Substitutions: Under provisions of Division 01.
 5. Housing: Material as selected by Architect.
 6. Device Plate: Material as selected by Architect.
 7. Receptacle configuration: Two duplex, back-to-back.
- B. Flush Cover Fitting:
1. Hubbell Model S-3825.
 2. Steel City Model P-64-DS.

3. Walker Model 827/828R.
4. Substitutions: Under provisions of Division 01.
5. Material: Material as selected by Architect.
6. Configuration: Duplex flap opening.

2.7 POKE-THROUGH FITTINGS

- A. Configurations:
 1. Combination type: assembly comprising poke-through component, firestops and smoke barriers, and service fitting with 2 duplex receptacles and bracket to hold up to 4 Category 5 communication jacks. Wiremold RC-4 series or equal.
 2. Hard-wired power type: assembly comprising poke through component, fire stops and smoke barriers and service fitting for connection of flexible conduit up to 3/4 inch size. Hubbell No. PT7FFGY or equal.
 3. Communication cabling type: assembly comprising poke through component, fire stops and smoke barriers and service fitting for passage of communications cabling. Unit shall maintain its fire rating without the necessity of any conduit fittings attached to the upper part. Hubbell no. HPWPT2FIT with HPWFF2BK cover/flange or equal.
- B. Fire Rating: 2 hours.
- C. Service Fitting:
 1. Type: Flush.
 2. Cover Plate: Thermoplastic; color as selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions under provisions of Division 2 – EXISTING CONDITIONS.
- B. Coordinate wiring device heights with benches and counters to verify that coverplate will fit above backsplash.
- C. Verify that outlet boxes are installed at proper height.
- D. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- E. Verify floor boxes are adjusted properly.
- F. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surfaces.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install in accordance with NECA Standard of Installation.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- E. Do not share neutral conductor on load side of dimmers.
- F. Install receptacles with grounding pole on top or right-hand side.
- G. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- H. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- I. Use jumbo size plates for outlets installed in masonry walls.
- J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings.
- K. Install tamper resistant receptacles in pediatric care areas, waiting rooms, and lobbies.
- L. Install hospital grade devices in all corridors and in patient bed locations.
- M. Install identifying nameplate on all receptacles (including receptacles in equipment furnished by others) as per Section 26 05 53— IDENTIFICATION FOR ELECTRICAL SYSTEMS.
- N. The architectural elevations take precedence of the Electrical Drawings for the device location and elevation. No outlets shall be installed until such heights have been established by the Architect.
- O. Devices shall be fastened solidly to outlet box extension rings in finished areas to assure a good ground connection. Where device does not meet box extension, install spacers as required for a solid connection.
- P. Plates shall be secured to the switches or receptacles with screws provided with the same. These screws shall be of the same finish as the plates. Care shall be taken in setting the plates that they do not buckle and shall be set square and plumb. Plates shall also be installed on all exposed outlet boxes regardless of system or designation. Verify all finishes with the Architect prior to installation.
- Q. Install blank trim plates on all unused outlets, junction boxes or telephone outlets.
- R. Surface mounted boxes shall have plates designed for surface mounted boxes, flush mounted boxes shall have plates designed for flush mounted installation.
- S. Provide stainless steel coverplates in all mechanical, central sterile, Engineering and Maintenance work area and kitchen areas
- T. Provide galvanized steel, gasketed weatherproof type in all exterior, damp or wet areas.
- U. Provide red coverplates on all receptacles connected to emergency power system.

3.4 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish. All site applied paint shall comply with VOC limits in Division 1.

END OF SECTION

SECTION 26 28 17 ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Circuit breakers used in unit substations, switchgear, distribution switchboards, and panelboards.
- B. Individually enclosed circuit breakers.

1.2 REFERENCES

- A. NECA (National Electrical Contractors Association) Standard of Installation.
- B. NEMA AB 1 - Molded Case Circuit Breakers.
- C. California Electrical Code (CEC) 2016 Edition
- D. California Building Code (CBC) 2016 Edition
- E. UL 489 – Molded Case Circuit Breakers

1.3 SUBMITTALS

- A. Comply with provisions of Section 01 330 - SUBMITTALS.
- B. Product Data: Provide catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with NECA Standard of Installation.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.

PART 2 - PRODUCTS

2.1 RELATED WORK

- A. Section 26 11 16 – SECONDARY UNIT SUBSTATION
- B. Section 26 24 16 – PANELBOARDS
- C. Section 26 24 13 – DISTRIBUTION SWITCHBOARDS 600 VOLTS AND BELOW

2.2 MANUFACTURERS

- A. Eaton
- B. Square D
- C. General Electric

2.3 600V AND BELOW BOARD MOUNTED CIRCUIT BREAKERS

- A. Main Section Devices: Individually fixed mounted, and compartmented.
- B. Distribution Section Devices: Panel mounted for 1200 ampere and smaller. Individually fixed mounted for larger than 1200 ampere.
- C. Feeder Circuit Breakers larger than 1200 ampere: Factory-assembled insulated case circuit breaker, fixed mounting construction. Breaker dual operated - either electrically or mechanically. Equip with electronic trip sensing. Provide ground protection for mechanical load feeders.
- D. Feeder Circuit Breakers 800 ampere through 1200 ampere: Provide molded case circuit breakers, manually operated. Equip with electronic trip sensing.
- E. Feeder Circuit Breakers 800 ampere and smaller: NEMA AB 1, molded case breaker with integral thermal and instantaneous magnetic trip in each pole.
- F. Feeder Circuit Breaker 800 ampere and smaller, and serving mechanical loads: Provide molded case circuit breakers, manually operated.
- G. Electronic Sensing: Provide microprocessor based selectable trip unit, self-contained and field changeable. Equip with following trip-timing functions and features:
 - 1. Protection: Long Time/Short Time Instantaneous, Ground, except where not required on drawings.
 - 2. Information: Provide cause of trip indicators.
 - 3. Testing: Provide field testing provisions. Include testing accessories, such as test kit.
 - 4. Field interchangeable rating plugs.
 - 5. Ground Protection: As indicated or otherwise noted.
- H. Ground Fault Protection: Ground fault sensing integral with circuit breakers. Provide zone selective interlocking.
- I. Interrupting Capacity: Minimum capacity as indicated on the drawings. Final capacity value based on the short circuit study completed under provisions of Section 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.

2.4 INSULATED CASE CIRCUIT BREAKER

- A. Circuit Breaker: NEMA AB 1, circuit breaker, commonly classified by manufacturers as insulated case" type.
- B. Factory-assembled circuit breaker with two-step stored energy mechanism and fully adjustable microprocessor based solid state trip unit. Breaker dual operated — either electrically or mechanically. Provide with electronic trip sensing, timing and tripping circuits for adjustable current settings, long-time pick-up and long-time delay, instantaneous trip, adjustable short time pickup

and delay, and a local open and close button. Ground Fault Sensing shall be integral with circuit breaker. Provide ground protection for mechanical load feeders and as shown on the drawings.

- C. Terminals shall be rated for 75 degrees Centigrade minimum.

2.5 MOLDED CASE CIRCUIT BREAKER

- A. Circuit Breaker: NEMA AB 1, bolt-on type thermal magnetic trip circuit breaker with trip sensor in each pole. Provide with common trip handle for all poles, listed as SWD for lighting circuits, type HACR for air conditioning equipment circuits. Do not use tandem circuit breakers.
- B. Feeder Circuit breakers 400A and larger frame size shall have solid state trip units.
- C. Terminals shall be rated for 75 degree Centigrade minimum.

2.6 TRIP UNITS

- A. Field-Adjustable Trip Circuit Breaker: Provide circuit breakers with frame sizes 800 amperes and larger with mechanism for adjusting long time continuous current setting for automatic operation.
- B. Field-Changeable Ampere Rating Circuit Breaker: Provide circuit breakers with frame size 400 amperes and larger with changeable trip units.
- C. Insulated case circuit breakers shall have metering capability with a display for voltage, current, power and energy readings. Metering capability to interface and report as part of electronic monitoring system provided as part of section 26 09 14 – ELECTRICAL POWER MONITORING.

2.7 PRODUCT OPTIONS AND FEATURES

- A. Provide accessories as indicated, to NEMA AB 1.
- B. Shunt Trip Device: 120 volts, unless otherwise noted. Provide 24 volt shunt trip device for elevator circuit breaker powered by fire alarm system.
- C. Handle Lock: Include provisions for padlocking, excluding all branch circuits panelboards
- D. Provide mechanical trip device.
- E. Provide Products suitable for use as service entrance equipment where indicated.

2.8 ENCLOSURE

- A. Enclosure: NEMA AB 1, Type or as suitable for use where indicated.
- B. Fabricate enclosure from steel.
- C. Finish using manufacturers standard enamel finish, gray color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 26 05 29- HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
- C. Provide engraved plastic nameplates under the provisions of Section 26 05 53- IDENTIFICATION FOR ELECTRICAL SYSTEMS.
- D. Series rating of overcurrent protection devices is not acceptable unless specifically noted on the drawings.

3.2 TESTING

- A. Field inspection and testing will be performed under provisions of Section 26 00 80 - TESTING REQUIREMENTS.
- B. Inspect and test each circuit breaker to NEMA AB 1.
- C. Inspect each circuit breaker visually.
- D. Perform several mechanical ON-OFF operations on each circuit breaker.

END OF SECTION

SECTION 26 36 00 TRANSFER SWITCHES

PART 1 GENERAL

1.1 SUMMARY

- A. This section includes labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:
 - 1. Automatic Transfer Switch and Bypass / Isolation Switch
- B. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation
- C. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 Specifications Sections apply to this section.

1.2 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. ANSI C37.90.1 IEEE Guide for Surge Withstand Capability (SWC) Tests
 - 2. NEMAICS1 General Standards for Industrial Control and Systems
 - 3. NEMAICS2 Standards for Industrial Control Devices, Controllers, and Assemblies
 - 4. NEMAICS3 Enclosures for Industrial Controls and Systems
 - 5. NEMAICS4 Terminal Blocks.
 - 6. NEMAICS6 Enclosures for Industrial Controls and Systems
 - 7. NEMAICS10 AC Transfer Switch Equipment
 - 8. UL467 Grounding and Bonding Equipment
 - 9. UL468A Wire Connectors and Wiring Lugs for Use with Copper Conductors
 - 10. IEC 947-6-1 Automatic Transfer Switching Equipment
 - 11. UL1008 Automatic Transfer Switches
 - 12. NFPA 110 Emergency and Standby Power Systems
 - 13. NFPA99 Essential Electrical Systems for Health Care Facilities
 - 14. UL 508 Industrial Control Equipment
 - 15. California Electrical Code (CEC) 2016 Edition
 - 16. California Building Code (CBC) 2016 Edition

1.3 SUBMITTALS

- A. Submit product data under the provisions of Division 1.
- B. Submit in accordance with the requirements of Section 260010- BASIC ELECTRICAL REQUIREMENTS, the following items:
 - 1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
 - 2. Describe system operation, equipment, and dimensions and indicate features of each component.
 - 3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
 - 4. Shop drawings shall include:
 - a. Front, plan and side view elevations with overall dimensions shown.
 - b. Location of devices and instruments and the make type, size and rating of all

- equipment.
 - c. Dimensional locations of conduit entry points and locations of barrier plates
 - d. Nameplate legends.
 - e. AIC rating.
 - f. Size and number of bus bars per phase, neutral and ground
 - g. Detailed point-to-point wiring diagram, differentiating between manufacturer-installed and field-installed wiring.
 - h. Identify control, signal, and alarm points for control and monitoring specified in these contract documents.
5. Furnish structural calculations for equipment anchorage as described in Section 260010-BASIC ELECTRICAL REQUIREMENTS.
 6. Factory test reports
 7. Certified independent laboratory test data shall be provided to confirm that the switch rating and design conforms to UL-I 008.
 8. Submit manufacturers installation instructions.
 9. Complete bill of material listing all components
 10. Warranty.
 11. Provide documentation of seismic compliance.
- C. Furnish a letter signed by a qualified representative of the switch assembly stating:
1. The manufacturer maintains a factory/parts warehouse within 50 miles of the jobsite, stocked with all parts for the automatic switch assembly.
 2. A factory authorized service representative lives within 50 miles of the jobsite.
 3. Parts and service are available year round on a 24-hour, 365 days per year basis.
 4. Response time to an emergency call from the jobsite for service or parts will not exceed three (3) hours.
- D. Dimensions and configurations of transfer switches shall conform to the space allocated on the drawings. The Contractor shall submit a revised layout if equipment furnished varies in size from that shown on drawings for the Architect's approval.
- E. Submit project specific total system control wiring diagram, including but not limited to all control, monitor, and alarm wire requirements to connect to paralleling switchgear, electronic metering, load add/load shed, and 24 hour remote monitor location required by NFPA 110 (level 1) and NFPA 99.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 1.
- B. Supply operation and maintenance manuals in accordance with the requirements of Section 260010— BASIC ELECTRICAL REQUIREMENTS, to include the following:
 1. A detailed explanation of the operation of the system
 2. Instructions for routine maintenance
 3. Detailed instructions for repair of the transfer switch.
 4. Pictorial parts list and part numbers.
 5. Pictorial and schematic electrical drawings of wiring systems, including operating and safety devices, control panels, instrumentation and annunciators
 6. Telephone numbers for the authorized parts and service distributors.
 7. Include all service bulletins and torque specifications for all terminations.
 8. Final testing reports

1.5 QUALIFICATIONS

- A. Manufacturer Service: Authorized service representative or facilities having minimum ten

years product repair experience and located within 100 miles of project and provides 24- hour, 7-day, emergency service.

- B. Supplier: Authorized distributor of specified manufacturer with minimum ten years experience.

1.6 QUALITY ASSURANCE

- A. Furnish products listed and classified by UL as suitable for purpose specified and indicated.
- B. Provide the services of a qualified testing agency to perform the specified tests. Notify in writing the Inspector and the Owner's Representative ten (10) working days in advance of performance of Work requiring testing. Provide all material required for testing.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 1.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturers written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as on shop drawings.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of transfer switch for one year from Date of Substantial Completion.

1.10 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Section 01 70 00- EXECUTION REQUIREMENTS.
- B. Provide two of each special tool required for maintenance.

1.11 WARRANTY

- A. Equipment offered under this Section shall be covered by a two (2) year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the Owner. Refer to Division 1 for the definition of acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. ASCO 7000 series
- B. Or equal

2.2 AUTOMATIC TRANSFER AND BYPASS/ISOLATION SWITCH

- A. Description: NEMA ICS 2, automatic transfer switch with manual bypass switch. Equip for safe and convenient means to manually bypass and isolate the automatic transfer switch regardless of the transfer switch condition or position.
- B. Configuration: Draw-out type, electrically-operated, mechanically-held transfer switch with

manually-operated CONNECTED, TEST, AND DISCONNECTED draw-out positions, and with mechanically-operated, mechanically-held transfer switch connected to bypass automatic switch in both NORMAL and EMERGENCY positions.

1. Draw-out Construction: Equip switch so that complete draw-out does not require disconnection of any hard-wired electrical devices or mechanical devices by maintenance personnel.
 2. Bypass Contacts: Provide overlapping or break-before-make bypass contact operation.
 3. Bypass Contact Operation Speed: Independent from handle movement speed.
 4. Electrically operated by a dual motor mechanism energized from the source to which the load is to be transferred. Mechanically and electrically interlocked in both directions.
 5. Double-throw type switching arrangement, and mechanically held in both directions
- C. All bussing shall be copper and silver-plated. Aluminum bus and cable interconnections shall not be acceptable
- D. Switch contacts shall be silver composition for switching load current. Units rated 225 amperes and more shall have separate arcing contacts.
- E. Where 4-pole switches are indicated, provide 100 percent rated neutral switching capacity, with fully rated (non-overlapping) contacts
- F. Train and bundle factory wiring and identify consistently with shop drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations. Check the following prior to installation:
1. Designated terminals accommodate field wiring
 2. Power terminal arrangement and field wiring space
 3. Pressure-type terminals, suitable for copper or aluminum conductors, sized as indicated.
 4. Control wiring equipped with lugs suitable for connection to terminal strips
- G. Bypass Switch Ratings: Match automatic transfer switch for electrical ratings.

2.3 RATINGS

- A. Voltage: 277/480 volts, three phase, four wire, 60 Hz.
- B. Switched Poles: 4-pole, switched non-overlapping neutral.
- C. Switch Operation: Open Transition, Bypass.
- D. Minimum Load Inrush Rating: 100-percent tungsten lamp load rated for 400 ampere and smaller switches. Combination load rated for switches larger than 400 amperes.
- E. Continuous Rating: As indicated on the Drawings.
- F. Withstand Current Rating: UL-1008; rated to withstand the available rms symmetrical short circuit current and coordinated with the type of overcurrent protection shown on the drawings.

2.4 PRODUCT OPTIONS AND FEATURES

- A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION, NORMAL BYPASS, ALTERNATE SOURCE BYPASS. Use LED or neon lamps.
- B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
- C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.
- D. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed.

- E. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value.
- F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 Hertz from rated nominal value.
- G. Double-Throw Operation: Equip switch for double-throw and neutral position operation by using dual electrical operators. Neutral position (center off position) used for inductive load transfers and load add/load shed capability.
- H. Electronic Metering: See Accessories.
- I. Switched Neutral: Non-Overlapping contacts.

2.5 AUTOMATIC SEQUENCE OF OPERATION

- A. Hospital Life Safety and Critical:
 1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
 2. Time Delay To Start Alternate Source Engine Generator: 0 to 3 seconds, adjustable. Factory set for one second.
 3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
 4. Time Delay Before Transfer to Alternate Power Source: 0 to 6 seconds, adjustable. Factory set for one second.
 5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
 6. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure. Factory set for fifteen minutes.
 7. Alternate power source failure during retransfer timing period: Provide timer override for immediate retransfer to normal power source.
 8. Time Delay Before Engine Shut Down: 0 to 15 minutes, adjustable, of unloaded operation. Factory set for five minutes.
- B. Hospital Equipment and Non-Essential transfer switches:
 1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
 2. Time Delay To Start Alternate Source Engine Generator: 0 to 3 seconds, adjustable. Factory set for one second.
 3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor, permission by alternate source monitor and permission from load control sequencing in Generator Control Switchgear.
 4. Time Delay Before Transfer to Alternate Power Source: 0 to 6 seconds, adjustable. Factory set for one second.
 5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
 6. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure. Factory set for fifteen minutes.
 7. Alternate power source failure during retransfer timing period: Provide timer override for immediate retransfer to normal power source.
 8. Time Delay Before Engine Shut Down: 0 to 15 minutes, adjustable, of unloaded operation. Factory set for five minutes.
- C. Load Shed Control: Provide relay control module to interface with Generator Control Switchgear.
- D. Provide staggered retransfer of loads. Provide 10 second delay for each switch. Follow order of switch retransfer as specified by facility engineering.

2.6 ENCLOSURE

- A. The ATS shall be a lockable, ventilated wall or floor mounted enclosure. The enclosure shall be NEMA 1 type, unless otherwise shown on the drawings.
- B. Transfer switch shall be NEMA ICS 6 type, smooth sheet metal enclosure constructed in accordance with UL 1008.
- C. Provide an engraved nameplate as "ATS No and "Name!! "Voltage 3 Phase, 4 Pole, "By Pass as applicable, per Section 260553- ELECTRICAL IDENTIFICATION.
- D. Provide Seismic Zone 4 certifications for installation and hardware.

2.7 ACCESSORIES

- A. Four auxiliary contacts, "closed" when the switch is in the "normal" position, and four additional auxiliary contacts, "closed" when switch is in the emergency position shall be provided as part of the ATS. Provide two contacts for each bypass position and for the center- off position. Contacts shall be rated 10 A @480 VAC.
- B. Bypass switch Ratings: Match automatic transfer switch for electrical rating.
- C. Load Shed relay energized by D.C. signal or remote contact closure to disconnect the load from the emergency source when an overloaded condition occurs. ASCO accessory 30.
- D. Block relay energized by D.C. signal or remote contact closure to allow transfer to emergency with 2 position key operated switch to bypass block transfer to emergency.
- E. 18B/G Source available contacts, Normal and Emergency wired to ION Meter.
- F. ASCO accessory 30 Generator Load Shed
- G. 31Z Selective Load Disconnect, Pre-transfer / Post-transfer
- H. Compression Lugs
- I. 72E Ethernet Adapter, ASCO 5150
- J. 82E Bypass Status Panel (Standard)
- K. 99 Push to test Pilot Lights
- L. 125 OSHPD Seismic Certification including OSP Labeling
- M. Schneider PM, ASCO accessory 113T Power Meter with
- N. Terminals for crimp type copper compression lugs (no set screw): Sources and Load Contractor include size and quantity of lugs with order
- O. Standard Selector Switch

2.8 FINISH

- A. Five step zinc phosphate pre-treatment, one coat of rust inhibiting dichromate primer and one coat baked-on enamel finish, Manufacturer standard gray enamel..

PART 3 EXECUTION

3.1 SITE CONDITIONS

- A. Thoroughly examine site conditions for acceptance of transfer switch installation to verify conformance with manufacturer and specification tolerances. Do not commence with

installation until all conditions are made satisfactory.

3.2 PREPARATION

- A. Insure all conduit stub-ups for bottom entry into transfer switch are in place and located as required per shop drawings.
- B. Provide a 4-inch high concrete housekeeping pad beneath equipment. Coordinate actual sizes of equipment base with shop drawings and extend pad 4 inches in all directions beyond overall dimension of base. Provide reinforcing bars as required structurally within pad to insure proper support of equipment.
- C. Embed in concrete two (2) 4-inch minimum channel iron sills, front and back edges of equipment, arranged per manufacturers' recommendations. Install sills flush in finished surface in contact with equipment mounting frame.

3.3 INSTALLATION

- A. Install ATS(es) in accordance with manufacturers instructions.
- B. Install ATS(es) in accordance with manufacturers written instructions, as shown on the drawings and as specified herein.
- C. Transfer Switches shall be anchored and braced to withstand seismic forces as required by the electrical equipment anchorage details.
- D. Tighten electrical connectors and terminals; including screws and bolts, in accordance with equipment manufacturers published torque-tightening values for equipment connectors. Where manufacturers torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque specified in NETA Standard Tables.
- E. Tighten and torque accessible bus connections and mechanical fasteners, in accordance with manufacturers instructions, after placing transfer switches. Mark torqued bolt heads using red or pink paint.
- F. Freestanding transfer switches shall be accurately aligned, leveled and bolted in place on full-length channels securely fastened per the structural engineers calculations.
- G. Conduits terminating in concentric, eccentric or oversized knockouts at transfer switch shall have ground bushings and bonding jumpers installed interconnecting all such conduits and the switch enclosure.
- H. Replace any panel pieces, doors or trims having dents, bends, warps or poor fit that may impede ready access, security or integrity.
- I. Provide engraved plastic nameplates under the provisions of Section 26 05 53- ELECTRICAL IDENTIFICATION.

3.4 SEISMIC MOUNTING

- A. Install transfer switches in accordance with the earthquake regulations of the California Building Code.

3.5 FACTORY TESTING

- A. Transfer switch shall be completely assembled, wired, adjusted and tested, per ANSI C37.20, at the factory under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The minimum of the following tests shall be performed and the documentation and measurements shall be included in Operation and Maintenance Manual.
 - 1. Dielectric test.
 - 2. Mechanical test.

- 3. Grounding of instrument transformers test
- 4. Electrical operation and control wiring test
- 5. Control wiring.
- 6. Polarity test.

- B. The complete ATS / BPS shall be factory tested with the emergency paralleling switchgear to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings, as well as remote load shed and transfer controls are in compliance with the specification requirements.
- C. Submit the certified test reports to the Architect to confirm that all components have been tested to substantiate designs according to applicable ANSI and NEMA Standards. Tests shall verify the performance of the components as well as the suitability of the enclosure venting, rigidity and bus bracing.

3.6 FIELD TESTING

- A. Provide the services of an authorized factory testing firm to perform the testing work.
- B. Visual and Mechanical Inspection:
 - 1. Inspect for physical damage.
 - 2. Compare nameplate information and connections to Drawings and Specifications.
 - 3. Check tightness of all control and power connections.
 - 4. Perform manual transfer operation.
 - 5. Confirm proper lubrication.
 - 6. Check switch to ensure positive interlock between normal and alternate sources.
 - 7. Ensure manual transfer warnings are attached and visible.
 - 8. Check that all covers barriers, and doors are secure.
- C. Electrical Tests:
 - 1. Perform insulation-resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
 - 2. Perform a contact-resistance test across all main contacts.
 - 3. Verify settings and operation of control devices in accordance with the Specifications of the Owners Representative.
 - 4. Calibrate and test all relays and timers including voltage and frequency-sensing relays, in-phase monitor (synchronism check), engine start and cooldown timers, transfer and retransfer timers, etc.
 - 5. Perform automatic transfer tests:
 - a. Simulate loss of normal power.
 - b. Return to normal power.
 - c. Simulate loss of emergency power.
 - d. Simulate all forms of single-phase conditions.
 - e. Monitor and verify correct operation and timing of the following simulations.
 - 1) Normal voltage-sensing relays.
 - 2) Engine start sequence.
 - 3) Time delay upon transfer.
 - 4) Alternate voltage-sensing relays.
 - 5) Automatic transfer operation.
 - 6) Interlocks and limit switch function.
 - 7) Time delay and retransfer upon normal power restoration.
 - 8) Engine cooldown and shutdown feature.
- D. Test Values:

1. Insulation-resistance test voltages.
2. Determine contact resistance in micro-ohms. Investigate any value exceeding 500 micro-ohms or any values which deviate from adjacent poles by more than 50 percent.

E. By-Pass/Isolation Switch:

1. Perform manual by-pass switch operation to different sources.
2. Verify that switch position indicating light operate correctly.
3. Manually isolate switch to testing and removing positions, then manually move switch to operating position.
4. Verify that all accessories as in place.

3.7 CLEANING

- A. Comply with the provisions of Division 1.
- B. Touch up scratched or marred surfaces to match original finish.
- C. Thoroughly wipe dirt and dust from devices and components. Vacuum transfer switch interior after cleaning devices.

END OF SECTION