SECTION 16010

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to, the following:

1. Examine all other sections for work related to those other sections and required to be included as work under this section.
2. General provisions and requirements for electrical work.
3. Division-1.

B. Organization of the specifications into divisions, sections and articles, and arrangement of drawings shall not control the CONTRACTOR in dividing the contract work among subcontractors or in establishing the extent of work to be performed by any trade.

1.02 GENERAL SUMMARY OF ELECTRICAL WORK

A. The specifications and drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material for the proper execution of the work in accordance with present practice of the trade shall not relieve the CONTRACTOR from providing such additional labor and materials.

B. Refer to the drawings and shop drawings of other trades for additional details, which affect the proper installation of this work. Diagrams and symbols showing electrical connections are diagrammatic only. Wiring diagrams do not necessarily show the exact physical arrangement of the equipment.

C. Before submitting a bid, the CONTRACTOR shall become familiar with all features of the building drawings and site drawings, which may affect the execution of the work. No extra payment will be allowed for failure to obtain this information.

D. If there are omissions or conflicts between the drawings and specifications, clarify these points with the OWNER'S REPRESENTATIVE before submitting bid and before commencing work.

E. Provide work- and material in conformance with the manufacturer's published recommendations for respective equipment and systems.

1.03 LOCATIONS OF EQUIPMENT

A. The drawings indicate diagrammatically the desired locations or arrangements of conduit runs, outlets, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work so as to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structure conditions encountered.

B. Where outlets are placed on a wall, locate symmetrically with respect to each other and other features or finishes on the wall.

C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without cost to the contract, providing the change is ordered before the conduit runs, etc., and work directly connected to same is installed and no extra materials are required.

D. Lighting fixtures in mechanical spaces are shown in their approximate location only. Do not install light outlets or fixtures until mechanical piping and ductwork is installed; then install lights in a location to provide best lighting.

E. Coordinate and cooperate in every way with other trades in order to avoid interference and assure a satisfactory job.

F. The location of the existing utilities, building, equipment and conduit shown on the drawings is approximate. Verify exact locations and routing of existing systems by potholing all trench routes prior to digging the trench. Pothole at least 100 feet ahead of the actual trenching to allow space to alter the new conduit routing to accommodate existing conditions.

G. Underground Detection Services Existing Utility Structures

1. Services shall be provided utilizing the latest detection equipment available. Services shall be performed by a company regularly engaged in the business of existing Underground Utility Structure Detection for the past five years.
2. Prior to excavation the following work shall be performed:
   a. Contractor to mark trenching locations and indicate width and depth.
   b. Locate, by way of vertical and horizontal control dimensions, existing subgrade petroleum product pipes, process piping, conduits, sewer, water, gas, storm drain, electrical, telephone and irrigation lines in the affected areas of contract construction work.
   c. Arrange and meet with the OWNER'S Representative to review existing underground conditions.
   d. The proposed route of each excavation shall be continuously surveyed along the entire excavation path using ground-penetrating radar (GPR) operating from the surface grade. The GPR shall detect and map existing underground metal and non-metal private and public utility lines, pipes, conduits, conductors, etc. The GPR shall identify the horizontal and vertical location of existing underground conditions located at a depth of up to 3 meters below finish grade and located with a vertical and horizontal accuracy within
      ± 12" of actual condition.
3. Exercise extreme caution in excavating and trenching on this site to avoid existing underground utilities, and to prevent hazard to personnel and/or damage to existing underground utilities or structures. These drawings and specifications do not include necessary components for construction safety, which is the responsibility of the CONTRACTOR.
4. Repair/replace, without additional cost to the contract, and to the satisfaction of the OWNER any existing work damaged that was identified in the record drawings provided; Identified by the Owner's Representative; Identified by the Underground Detection Services performed; or any existing work damaged as a result of failure to comply with all the referenced requirements.

5. The CONTRACTOR shall contact Underground Service Alert (USA) of Southern California, at least 48 hours prior to excavation, and shall not excavate until verification has been received from the USA and that public utilities serving the site have been located and marked.

H. The locations of existing underground utilities, where shown on drawings, are shown diagrammatically and have not been independently verified by the OWNER, the OWNER'S REPRESENTATIVE, the Architect/Engineer. The OWNER, the OWNER'S REPRESENTATIVE, and the OWNER's Architect/Engineer are not responsible for the location of underground utilities or structures, whether or not shown or detailed and installed under this or any other contracts. The CONTRACTOR shall identify each existing utility line prior to excavation and mark the locations on the ground of each existing utility line.

1.04 AIR CONDITIONING, HEATING, PLUMBING EQUIPMENT WIRING

Provide electrical work, materials, and control components required for proper operation of the air conditioning, heating and plumbing systems as indicated on the electrical, mechanical, and plumbing Contract Documents and specified herein.

1.05 POWER, TELEPHONE AND OTHER SIGNAL SERVICES

A. Telephone, cable television, power, street lighting service and metering facilities shall conform to the requirements of the serving utility companies. CONTRACTOR shall verify service locations and requirements, and shall pay all costs levied by the serving utility companies for rendering utility services to the contract without additional cost to the OWNER. Service information will be furnished by the serving utilities. Comply with requirements of the OWNER'S telephone supplier.

B. Conform to all requirements of the serving utility companies. Location of transformer pad and or manholes and pull boxes and routing of service conduits indicated on the drawings are approximate and shall be verified with the serving utility company prior to installation. Installation of service shall not begin until approved drawings have been received from the serving utility company.

C. Within 30 calendar days of receipt of notice that the contract award has been made, the CONTRACTOR shall notify the New Business Departments of the District Office of the serving utility companies concerning the project contract and shall provide information as to the total lighting, power, telephone, and signal requirements of the contract. The CONTRACTOR shall furnish at the same time information as to the estimated completion date of job or the date when the respective utility company circuits, will be ready for installation, energizing and activation of the respective services.

D. In addition to the requirements of the serving utility companies, all power, telephone and signal service conduits for utility company circuits, shall be completely encased in concrete on all sides, top and bottom. The concrete shall be red mix color and extend a minimum of three inches past the conduit.

E. Contractor shall submit Electrical Utility metering and electrical service entrance equipment shop drawings to the Electric Utility Company supplying the project for review and approval by the serving Utility Company. The submittal and acceptance by the Utility shall occur prior to submitting of shop drawings to the OWNER'S Representative or A/E for review. Copies of the serving Electrical Utility approval of the equipment shall be in included in the shop drawings submittals to the OWNER'S Representative and A/E.

1.06 PERMITS

Obtain and pay for all required permits, inspections and examinations without additional cost to the OWNER.

1.07 QUALITY ASSURANCE

A. Work and materials shall be in full accordance with the latest rules and regulations as follows. The following publications shall be included in the contract documents requirements. If a conflict occurs between the following publications and any other part of the contract documents, the requirements describing the more restrictive provisions shall become the applicable contract definition:

1. California Code of Regulations Title 24.
2. California Part 3 "California Electrical Code" CEC, Title 24 and Title 8 "Division of Industrial Safety".
3. California Building Code - CBC.
4. The National Electrical Code.
5. The National Life Safety Code.
6. The Uniform Building Code-UBC.
7. National Fire Protection Agency-NFPA.
8. Underwriter's Laboratory-UL.
9. Other applicable State and Local Government Agencies laws and regulations.
10. Electrical Installation Standards National Electrical Contractors Association (NECA) and National Electrical Installation Standards (NEIS):

a.	NECA/NEIS-1:	Standard of Practices for Good Workmanship in Electrical Contracting
b.	NECA/NEIS-101:	Standard for Installing Steel Conduit (Rigid, IMC, etc.)
c.	NECA/NEIS-111:	Recommended Practice Installing Nonmetallic Raceways
d.	NECA/NEIS-230:	Recommended Practice for Installing Motors
e.	NECA/FOA-301:	Standards for Installing and Testing Fiber Optic Cables
f.	NECA/NEIS-305:	Standard for Fire Alarm System Job Practice
g.	NECA/NEIS–331:	Standards for Installing Building and Service Entrance Grounding
h.	NECA/NEIS-400:	Recommended Practice for Installing and Maintaining Switchboards
i.	NEIS/NECA & EGSA-404:	Recommended Practice for Installing Generator Sets
j.	NECA/NEIS-407:	Recommended Practice for Installing Panelboards
k.	NECA/NEIS-408:	Recommended Practices for Installing Busway
l.	NECA/NEIS-409:	Recommended Practice for Installing and Maintaining Dry-Type Transformers
m.	NEIS/NECA & IESNA-500:	Recommended Practice for Installing Indoor Commercial Lighting Systems
n.	NEIS/NECA & IESNA-501:	Recommended Practice for Installing Exterior Lighting Systems
o.	NEIS & IESNA-502	Recommended Practice for Installing Industrial Lighting Systems
p.	NECA/BICSI-568:	Standards for Installing Commercial Building Telecommunications System

B. All material and equipment shall be new and shall be delivered to the site in unbroken packages. All material and equipment shall be listed and labeled by Underwriters Laboratories or other recognized testing laboratories, where such listings are available. Comply with all installation requirements and restrictions pertaining to such listings.

C. Work and material shown on the drawings and in the specifications is new and included in the contract unless specifically indicated as existing or N.I.C. (not in contract).

D. Keep a copy of all applicable codes and standards available at the job site at all times for reference while performing work under this contract. Nothing in plans or specifications shall be construed to permit work not conforming to the most stringent of building codes.

E. Where a conflict or variation occurs between applicable Codes, standards and/or the Contract Documents, the provisions of the most restrictive provision shall become the requirement of the Contract Documents.

1.08 SUBMITTALS

A. General

1. Review of CONTRACTOR'S submittals is for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. CONTRACTOR is responsible for quantities; dimensions which shall be confirmed and correlated at the job site; fabrication processes and techniques of construction; coordination of work with that of all other trades and satisfactory performance of their work.
2. The CONTRACTOR shall review each submittal in detail for compliance with the requirements of the contract documents prior to submittal. The CONTRACTOR shall "Ink Stamp" and sign each item of the submittal with a statement "CERTIFYING THE SUBMITTAL HAS BEEN REVIEWED BY THE CONTRACTOR AND COMPLIES WITH ALL THE REQUIREMENTS OF THE CONTRACT DOCUMENTS". The CONTRACTOR shall clearly and specifically identify each individual proposed substitution, substitution of equal, or proposed deviation from the requirements of the contract documents with a statement "THIS ITEM IS A SUBSTITUTION".
   The burden of research, preparation of calculations and the furnishing of adequate and complete shop drawings information to demonstrate the suitability of CONTRACTOR's proposed substitutions and suitability of proposed deviations from the contract documents is the responsibility of the CONTRACTOR.
3. Departure from the submittal procedure will result in resubmittals and delays. Failure of the CONTRACTOR to comply with the submittal requirements shall render void any acceptance or any approval of the proposed variation. The CONTRACTOR shall then be required to provide the equipment or method without variation from the contract documents and without additional cost to the contract.
4. The CONTRACTOR at no additional cost or delays to the contract shall remove any work, material and correct any deficiencies resulting from deviations from the requirements of the contract documents not approved in advance by the OWNER prior to commencement of work.
5. Shop drawings submitted by the CONTRACTOR, which are not specifically required for submittal by the Contract Documents, or CONTRACTOR shop drawings previously reviewed and resubmitted without a written resubmittal request to the CONTRACTOR, will <u>not</u> be reviewed, considered, or commented on. The respective shop drawing submittal/resubmittal will not be returned to the CONTRACTOR and will be destroyed without comment or response to the

CONTRACTOR. The respective submittal shall be considered null and void as being not in compliance with the requirements of the Contract Documents.

6. Refer to Division-1 for additional requirements.

B. Material Lists and Shop Drawings

1. Submit material list and equipment manufacturers for review per Section 01350. Give name of manufacturer and where applicable, brand name, type and/or catalog number of each item. Listing of more than one manufacturer for any one item of equipment, or listing items "as specified", without both make and model or type designation, is not acceptable. Shop drawings shall not be submitted before review completion of manufacturers list. The right is reserved to require submission of samples of any material whether or not particularly mentioned herein.
2. After completion of review of the material and equipment manufacturers list, submit shop drawings for review. Shop drawings shall be submitted in completed bound groups of materials (i.e., all lighting fixtures or all switchgear, etc.). The CONTRACTOR shall verify dimensions of equipment and be satisfied as to fit and that they comply with all code requirements relating to clear working space about electrical equipment prior to submitting shop drawings for review. Submittals, which are intended to be reviewed as substitution or departure from the contract documents, must be specifically noted as such. The requirements of the contract documents shall prevail regardless of the acceptance of the submittal.
3. Shop drawings shall include catalog data sheets, instruction manuals, dimensioned plans, elevations, details, wiring diagrams and descriptive literature of component parts where applicable. Structural calculations and mounting details, signed by a Structural ENGINEER registered by the State of California, shall be submitted for all equipment weighing over four hundred pounds, and shall be in compliance with Title 21 of the California Code of Regulations.
4. Each shop drawing item shall be identified with the specification section and paragraph numbers, lighting fixture types and drawing sheet numbers; the specific shop drawing is intended to represent. Shop drawings 11" x 17" or smaller in size shall be bound in 3-ring binders. Divider tabs shall be provided in the 3-ring binders identifying and separating each separate shop drawing submittal item. Shop drawings larger than 11" x 17", shop drawing pages/sheets submittals shall be sequentially numbered with unique alphanumeric numbering system to facilitate correspondence referencing identification of individual sheets.
5. Shop drawings shall include the manufacturers projected days for shipment from the factory of completed equipment, after the CONTRACTOR releases the equipment for production. It shall be the responsibility of the CONTRACTOR to insure that all material and equipment is ordered in time to provide an orderly progression of the work. The CONTRACTOR shall notify the OWNER'S Representative of any changes in delivery, which would affect the project completion date.
6. Submittal Identification
   a. Each submittal shall be dated: with submittal transmission date; sequentially numbered and titled with submittal contents identification and applicable specification/drawing references *(i.e., Submittal dated: 5/12/98 Submittal #4 Contents: Branch circuit panelboards Sheet #E5.1 and transformers Specification Section 16050 Paragraph 2.11, etc.)*.

b. Each resubmittal shall be dated: with original submittal date and resubmittal transmission dates; sequentially numbered with original submittal number and sequential resubmittal revision number and titled with submittal contents identification and applicable specifications/ drawing references *(i.e., Original Submittal Date: 5/12/98 Resubmittal Date: 10/9/98 Original Submittal #4 resubmittal Revision R2 Contents: Transformer resubmittal Specification Section - 16050 Paragraph 2.11, etc.)*

C. The CONTRACTOR shall be responsible for incidental, direct and indirect costs resulting from the CONTRACTOR'S substitution of; or changes to; the specified contract materials and work.

D. Maintenance and Operating Manuals

1. The CONTRACTOR shall furnish four copies of typewritten maintenance and operating manuals for all electrical equipment, fire alarm equipment, sound system equipment, etc., to the OWNER. Per the requirements of Section 01730.
2. Instruct OWNER'S personnel in correct operation of all equipment at completion of project. Provide the quantity and duration of instruction class as specified; but in no case less than one (1) four (4) hour duration separate instruction classes for each individual equipment group furnished as part of the contract. Instruction classes shall be presented by Manufacturer's authorized field service ENGINEER at the project site. Instruction class size shall be at the OWNER'S discretion, not less than one (1) or more than fifteen (15) students shall attend each instruction session. Submit 15-written outline copies of the proposed instruction class curriculum, 14 days prior to the class scheduled dates.

E. Portable or Detachable Parts: The CONTRACTOR shall retain in his possession, and shall be responsible for all portable and detachable parts or portions of the installation such as fuses, keys, locks, adapters, locking clips, and inserts until final completion of contract work. These parts shall then be delivered to the OWNER's Representative with an itemized receipt.

F. Record Drawings

1. Provide and maintain in good order a complete set of electrical contract "record" prints. Changes to the contract to be clearly recorded on this set of prints on a daily basis. Submit to Architect upon project connection.
2. The actual location and elevation of all buried lines, boxes, monuments, vaults, stub-outs and other provisions for future connections shall be referenced to the building lines or other clearly established base lines and to approved bench marks. If any necessary dimensions are omitted from the record drawings, the CONTRACTOR shall, at THE CONTRACTOR'S own expense, do all excavation required to expose the buried work and to establish the correct locations.
3. The CONTRACTOR shall keep the "record" prints up to date and current with all work performed.
4. Refer to Division-1 for additional requirements.

1.09 CLEANING EQUIPMENT, MATERIALS, PREMISES

All parts of the equipment shall be thoroughly cleaned of dirt, rust, cement, plaster, etc., and all cracks and corners scraped out clean. Surfaces to be painted shall be carefully cleaned of grease and oil spots and left smooth, clean and in proper condition to receive paint finish.

1.10 JOB CONDITIONS - PROTECTION

Protect all work, materials and equipment from damage from any cause whatever and provide adequate and proper storage facilities during the progress of the work. Provide for the safety and good condition of all the work until final acceptance of the work by the OWNER and replace all damaged or defective work, materials and equipment before requesting final acceptance.

1.11 PROTECTION OF SERVICES

A. The Contractor, at his own expense, shall repair, replace and maintain in service any utilities, facilities, or services (underground, overground, exterior, interior) damaged, broken or otherwise rendered inoperative during the course of construction. Refer to General Conditions, Supplementary Conditions and Division 1.

1.12 EXCAVATION, CUTTING, BACKFILL AND PATCHING ADDITIONAL REQUIREMENTS

A. General
   1. Perform excavation, cutting, backfill, core drilling, directional boring, and patching of the construction work required for the proper installation of the electrical work.
   2. Patching shall be of the same material, thickness, workmanship and finish as existing and accurately match surrounding work to the satisfaction of the OWNER'S Representative.

B. Excavation Temporary Cover
   1. Excavations for contract work occurring in streets, vehicular drive areas, parking lots, sidewalks or any paved surface; provide temporary steel plating and shoring support for the plates, to completely cover the excavations under one or more of the following conditions:
      a. Excavation shall not remain "open" for more than four (4) calendar days; provide temporary plating.
      b. Excavation shall not be "open" over weekends (Saturday, Sunday) or Holidays, provide temporary plating.
   2. The temporary plating shall be a minimum of 0.75-inch thickness steel, but in no case shall the thickness be less than required to support AASHO-H20 traffic loading.

1.13 IDENTIFICATION

A. Equipment Nameplates
   1. Panelboards, terminal cabinets, circuit breakers, disconnect switches, starters, relays, time switches, contactors, push-button control stations, and other apparatus used for the operation or control of feeders, circuits, appliances, or equipment shall be properly identified by means of descriptive nameplates or tags permanently attached to the apparatus and wiring.
   2. Electrical equipment including switchgear, switchboards, electric panels and control panels, motor control centers, combination motor starters, transformers, disconnects, etc., shall each be labeled by the manufacturer with "Electric-ARC-FLASH" warning signs. The signs shall explain a hazard to personnel may exist if the equipment is worked on while energized or operated by personnel while energized. The sign shall instruct personnel to wear the correct protective equipment/clothing (PPE) when working "Live", or operating "Live" electrical equipment and circuits.
   3. Nameplates shall be engraved laminated phenolic. Shop drawings with dimensions and format shall be submitted before installation. Attachment to equipment shall be with escutcheon pins, rivets, self-tapping screws or machine screws. Self-adhering or adhesive backed nameplates shall not be used.

4. Provide black-on-white laminated plastic nameplates engraved in minimum 1/4" high letters to correspond with the designations on the drawings. Provide other or additional information on nameplates where indicated. Nameplates shall also describe serving upstream equipment, (i.e., "fed by MSB").

B. Plates: All cover and device plates shall be label with E-Z markers or Dymo tape indicating panel and circuit number.

C. Receptacles, switches and lighting fixtures shall be legibly penmarked with permanent marker inside the device cover or box showing panel, circuit breaker and relay designation.

D. For equipment and access doors or gates to equipment containing or operating on circuits of more than 240 volts nominal, provide red-on-white laminated warning signs engraved in 1/2" high letters to read: "DANGER - 480 *(or applicable voltage)* VOLTS KEEP OUT AUTHORIZED PERSONNEL ONLY".

E. Wire and Cable Identification

1. Provide identification on individual wire and cable including signal systems, fire alarm, electrical power systems (each individual phase, neutral and ground), empty conduit pull ropes, and controls circuit.
2. Permanent identification shall be provided at each termination location, splice location, pullbox, junction box and equipment enclosure.
   a. Individual wire and cable larger than #6 AWG or 0.25 inch diameter, shall be provided with polypropylene identification tag holders, with yellow polypropylene tags interchangeable black alpha/numeric characters, character height 0.25 inch. Attach identification tags with plastic "tie" wraps, minimum of two for each tag. As manufactured by Almetek Industries-"EZTAG" series; or TECH Products - "EVERLAST" series.
   b. Individual wire and cable #6 AWG and smaller or smaller than 0.25 inch diameter, shall be provided with water and oil resistant, flexible, self-laminating pressure sensitive machine embossed plastic tags that wrap a minimum of 360 degrees around the wire/cable diameter. The entire tag shall then be covered with a clear flexible waterproof plastic cover wrapped a minimum of 540 degrees around the wire/cable diameter and completely covering the identification. As manufactured by: Brady Identification; or 3M; or Panduit.
   c. Each identification tag location shall indicate the following information: circuit number, circuit phase, source termination and destination termination equipment name (or outlet number as applicable).
3. Install permanent identification after installation/pulling of wire/cable is complete, to prevent loss or damage to the identification.

E. Cardholders and cards shall be provided for circuit identification in panelboards. Cardholders shall consist of a metal frame retaining a clear plastic cover permanently attached to the inside of panel door. List of circuits shall be typewritten on card. Circuit description shall include name or number of circuit, area, and connected load.

F. All junction outlet and pull boxes shall have covers penmarked circuit numbers according to panel schedule. Data shall be lettered in a conspicuous manner with a color contrasting to finish using permanent marker.

1.14 TESTING

A. The CONTRACTOR shall obtain an independent testing laboratory that will provide all instrumentation and tests on the electrical system and equipment as hereinafter described and further directed by the OWNER's Representative. The test shall be performed after the completion of all electrical systems included in the Contract Scope of Work. All tests shall be recorded and documented and submitted to the OWNER'S Representative for review.

1. Test for Phase to Ground and Neutral Condition:
   a. Open main service disconnects.
   b. Isolate the system neutral from ground by removing the neutral disconnects link located in the service switchboard.
   c. Close all submain disconnects.
   d. Close all branch feeder circuit breakers.
   e. Turn all switches to "on" position, unplug all portable equipment from outlet receptacles.
   f. Measure the resistance of each phase to ground and phase to neutral. A properly calibrated "megger" type test instrument shall be used. The test voltage shall be a nominal 500 volts.
   g. Record all readings after one minute duration and document into a complete report.
2. Isolating Grounds: In the event that low resistance ground neutral connections are found in the system, they shall be isolated and located by testing each circuit individually as outlined above. Make proper corrections to restore the resistance values to an acceptable value.

B. Method of obtaining ground resistance shall be in accordance with the latest edition of the James G. Biddle (Plymouth Meeting, Pennsylvania) manual published on this subject.

1. Perform "fall-of-potential" 3-point tests on the main grounding electrode of system per IEEE Standard No. 81, Section 8.2.1.5. when suitable locations for test rods are not available, a low resistance dead earth or reference ground shall be utilized.
2. Perform the two-point method test per IEEE Standard No. 81, Section 8.2.1.1, to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

C. All equipment and personnel required for testing shall be furnished by the CONTRACTOR.

D. The testing, calibrating and setting of all ground and ground fault equipment circuit breakers, device protection relays, and meters adjustable settings shall be by an independent testing laboratory. Set as recommended by the respective manufacturer and coordination study so as to be coordinated with other protection devices within the electrical design. Bound and tabulated copies of the test and settings shall be sent to the OWNER'S Representative.

E. Ampere and Voltage Measurements

1. Take and record ampere and line voltage measurements under full load on all panel feeders, switchboard and switchgear feeders, motor control centers and motor circuits provided in the contract. Record measurements at the equipment tested and submit to the OWNER's Representative for review.
2. Ampere voltage readings shall be:
   a. Phase A-B, A-C and B-C.
   b. Phase A-Neutral, B-Neutral and C-Neutral.

3. The ampere and voltage readings shall be not less than 20 minutes duration for each test. Record and submit the measured minimum, maximum and 20 minute average for each ampere and voltage value and test location. Voltage and ampere measurements shall occur at the connected load end of each respective feeder, not at the source of supply end of each feeder.
4. Test equipment shall be accurate within plus or minus 1-percent.
5. Branch circuit devices 40 ampere or less and motor loads 10 horsepower or smaller are excluded from ampere and voltage testing requirement.
6. If, in the opinion of the OWNER'S Representative, the voltages and regulations are not met within acceptable limits, make arrangements with the serving utility for proper electrical service. Retest feeder line voltages, and submit to OWNER'S Representative for review, after the utility company has completed corrective actions. Reset "voltage taps" on transformers provided or modified as part of the contract work, to adjust line voltages to within acceptable values, as directed by the OWNER'S Representative.

F. The Contractor shall complete the following work before any electrical equipment is energized.
1. All equipment shall be permanently anchored.
2. All bus connections shall be tightened per manufacturer's instructions and witnessed by the OWNER'S Representative.
3. All ground connections shall be completed and identified. Perform and successfully complete all required megger and ground resistance tests.
4. All feeders shall be connected and identified.
5. The interiors of all electrical enclosures including busbars and wiring terminals shall be cleaned of all loose material and debris, paint, plaster, cleaners or other abrasive's overspray removed and equipment vacuumed clean. The OWNER'S Representative shall observe all interiors before covers are installed.
6. All dry wall work and painting shall be completed within areas containing electrical equipment prior to installation of equipment.
7. All doors to electrical equipment rooms shall be provided with locks in order to restrict access to energized equipment.
8. Electrical rooms shall not be used as a storage rooms after power is energized.
9. The electrical system coordination study shall be complete for circuit breakers, ground relays sets, and circuit relay sets, fuses; tested and calibrated accordingly.

1.15 POWER OUTAGES

A. All electrical services in all occupied facilities of the contract work are to remain operational during the entire contract period. Any interruption of the electrical services for the performance of this work shall be at the convenience of the OWNER and performed only after consultation with the OWNER'S Representative. Work involving circuit outages shall be only at such a time and of such a duration as approved in writing. Work involving circuit outages for the work required to connect new equipment and disconnect existing equipment shall be performed at the convenience of the OWNER.

1.15 ASBESTOS, POLYCHLORINATED BIPHENYL (PCB) OR HAZARDOUS WASTE:

A. If asbestos, PCB or any hazardous waste material is encountered, notify the OWNER'S Representative immediately. Do not disturb, handle or attempt to remove.

1.16 SERIES RATED EQUIPMENT

Circuit protective Devices identified as "Series Rated" or "Current Limiting" (i.e., CLCB - current limiting circuit breaker; CLF - current limiting fuse, etc.) shall be series rated and tested (UL 489 & CSA5) by the manufacturer with all equipment and circuit protective devices installed down stream of the identified series rated or current limiting device. Provide nameplates on all equipment located down stream, including the CLCB and CLF devices, to comply with N.E.C. paragraphs 110-22 and 240-83 "CAUTION SERIES RATED SYSTEM - NEW DEVICE INSTALLATIONS AND REPLACEMENTS SHALL BE THE SAME MANUFACTURER AND MODELS".

1.17 INDEPENDENT TESTING LABORATORY

A. Testing Laboratories Definition
   1. The Testing Laboratory shall meet Federal OSHA criteria for accreditation of Nationally Recognized Testing Laboratories (NRTL) Title 29 Part 1907 and 29 CFR-1910.
   2. Membership in the National Electrical Testing Association (NETA) shall also constitute acceptance of meeting said criteria, for testing of electrical systems.

1.18 SPARE FUSES

Provide three (3) spare fuses for each size and type to match the installed fuses where the fuses are provided as part of the Contract. Provide spare fuse holders on inside door of each respective fuse compartment. Provide engraved nameplate on front of fuse access door indicating fuse type/catalog number ampere rating and manufacturer of fuse.

1.19 EQUIPMENT SEISMIC REQUIREMENTS

A. Equipment supports and anchorage's provided as part of the contract shall be designed, constructed and installed in accordance with the earthquake regulations of the California Building Code, Title 24, Section 1632A, and the Uniform Building Code (UBC).

B. Provide equipment anchorage details, coordinated with the equipment mounting provision, prepared, signed and "stamped" with PE registration by a civil or structural engineer licensed as a Professional Engineer (PE) in the State of California.

C. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of that type of equipment.

D. The equipment manufacturer shall certify that the equipment can withstand, and function following the seismic event, including both vertical and lateral required response spectra as specified in California Title 24 and the UBC. Alternatively, the manufacturer's certification may be based on an approved detailed structural analysis of the assembly, as specified in California Title 24 and the UBC.

E. The equipment manufacturer shall document the details necessary for proper seismic mounting, anchorage, and bracing of the equipment for back installation location.

F. Seismic qualification shall be considered achieved when the capability of the provided equipment, as described by the test response spectra, meets or exceeds the required response spectra as specified in California Title 24 and the UBC, for all equipment natural frequencies up to 35 HZ.

G. The seismic requirements are typical for each equipment item exceeding 100 pounds, including but not limited to the following.
   1. Switchgear, switchboards, and motor control centers
   2. Transformers
   3. Equipment racks
   4. Panels
   5. Conduits with ceiling or wall support suspension attachments.
   6. Busway and cable tray
   7. Uninterruptible power supplies (UPS)
   8. Generators and related equipment
   9. Lighting equipment

H. Wall Mounted Electrical Equipment
   1. Surface Mounted Equipment
      a. Provide multiple horizontal sections of metal "C" channels for support and attaching wall mounted equipment to walls. Channels shall provide "turned lips" at longitudinal edges to hold "lock-in" fasteners and shall comply with ANSI-1008 and ASTM-A569 latest revision. The channels shall be steel hot dip zinc galvanized. As manufactured by Unistrut or Kindorf.
      b. The "C" channels shall be positioned horizontally within 3 inches of the top and bottom of each, equipment section cabinet and located behind each equipment vertical section. Provide additional intermediate "C" channels at not less than 36 inches on center between the "top" and "bottom" "C" channel positions, located behind each equipment vertical section.
      c. The "C" channels shall be of sufficient length to provide connection to not less than two (2) vertical structural wall framing elements separated by not less than 16 inches; but in no case shall the "C" channel length be less than the width of the respective equipment section.
      d. Attach the "C" channels to the wall structural elements after the wall, finish surface, installation (including painting) is complete.
      e. Attach the "C" channels with fasteners to the building wall framing structural elements as follows: welded to steel framing; bolted to wood framing; cast in place concrete inserts for masonry and concrete construction; drilled "afterset" expansion anchors for existing masonry and concrete construction.
      f. Attach the equipment to the "C" channels with threaded and bolted fasteners to "prelocate" and lock into the channel "turned lips" and channel walls.

1.20 ELECTRICAL WORK CLOSEOUT

A. Prepare the following items and submit to the OWNER'S REPRESENTATIVE before final acceptance, per the requirements of Section 01700.
   1. Two copies of all test results as required under this section.
   2. Two copies of local and/or state code enforcing authorities final inspection certificates.
   3. Copies of record drawings as required under the General Conditions, pertinent Division One Sections and Electrical General Provisions.
   4. Two copies of all receipts transferring portable or detachable parts to the OWNER'S Representative when requested.

5. Notify the OWNER's Representative in writing when installation is complete and that a final inspection of this work can be performed. In the event any defect or deficiencies are found during this final inspection they shall be corrected to the satisfaction of the OWNER's Representative before final acceptance can be issued.
6. List of spare fuses and locations identified by equipment name and building designation.
7. Prior to energizing, retighten to the proper torque, each circuit conductor lug landing, each bus bar (phases, neutral and ground) and circuit protection device threaded connections in all switchboards, switchgear, motor control centers, transformers, busways, disconnect switches, motor starters, motor terminals and panelboards, after the equipment is installed/connected and prior to energizing the equipment. The torque values shall comply with manufacturer's recommendations.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS

A. Submit product data sheets for all outlet boxes, floor boxes, wiring devices, device plates, relays, contactors, timeswitches, and disconnects fuses.

B. Submit detailed shop drawings including dimensioned plans, elevations, details, schematic and point-to-point wiring diagrams and descriptive literature for all component parts for transformers, relays, time clocks, and photocells.

C. Submit transformer test reports.

D. Submit material list for outlet boxes.

PART 2 - PRODUCTS

2.01 OUTLET AND JUNCTION BOXES

A. General
   1. Flush or concealed outlet and junction boxes: Pressed steel, steel thickness not less than 0.062-inch, hot-dip galvanized, knockout (KO) type with conduit entrances and quantities size to match conduits shown
      connecting to respective outlet box. UL-514 listed and labeled. Minimum required box depth is exclusive of extension-ring depth.
   2. Provide boxes of proper code size for the number of wires or conduits passing through or terminating therein, but in no case shall box be less than 4.0 inch square by 2.125 inch deep, unless specified elsewhere or noted otherwise on the drawings. 2.5 inch minimum depth for box widths exceeding 2-gang.
   3. Increase the minimum outlet box size to 4.69 inches square by not less than 2.125 inches deep, where one or more of the following conditions occurs:
      a. More than two (2) conduits connect to the outlet box.
      b. Conduit "homerun" connects to outlet box.
   4. Provide extension rings on flush outlets to finish face of extension ring flush with finished building surfaces. Extension ring shall match outlet box construction and contain "attachment mounting-tabs" for wiring devices. Extension rings shall be "screw-attached" to respective outlet box and maintain "ground" bonding continuity.

5. Boxes installed in masonry or concrete shall be UL "concrete-tight" approved for installation in concrete, and shall allow the placing of conduit without displacing reinforcing bars.
6. Provide fixture-supporting device in outlet boxes for surface mounted fixtures as required.
7. Provide solid gang boxes for three or more switches, for mounting behind a common device plate.
8. Provide barriers for all 277 volt devices, between line voltage and low voltage devices and where more than one device is installed in an outlet box.
9. Individual audio/visual, telephone, computer or data outlets: 4.69 inch square by 2.125 inch deep minimum with two gang [single gang] gang extension ring on flush boxes.
10. Combination signal/telephone/data or computer outlets: 4.69 inch square by 2.125 inch deep minimum with 2-gang wide extension ring on flush boxes.
11. Duplex-Combi and Quad-Combi flush mount, outlet box metal construction, sizes as shown on the drawings, but not less than the following sizes:
    a. Duplex-Combi box, nominal 3-gang wide x 3.0-inch deep. Provide 2-gang wide "reducer" extension ring and high/low potential internal box dividers on box.
    b. Quad-Combi box, nominal 5-gang wide x 3.0-inch deep. Provide 4-gang wide "reducer" extension ring and high/low potential internal box dividers on box.
    c. Single piece common, nonmetallic coverplate, device mounting brackets with wiring devices for data/communication outlet keystones and duplex convenience receptacles.
    d. As manufactured by Wiremold WallSource Series; or Hubbell Multi-Connect series, multiple service recess outlet boxes.

B. Surface Outlet Boxes
1. Surface mounted outlet boxes, cast iron Type FS or FD, with threaded hubs as required. Box interior dimensions and interior volume capacity not less than required for "press steel boxes", and "sheet steel boxes". Provide plugs in all unused openings. Provide weatherproof gaskets for all exterior boxes.

C. Floor Boxes
1. Cast iron, concrete tight with leveling screws adjustable floor ring, rectangular brass cover and clear polycarbonate carpet flange, minimum floor box clear inside depth not less than 3-inches.
2. Boxes:
    a. Single gang: Hubbell #B-2436
    b. Two gang: Hubbell #B-4233
    c. Three gang: Hubbell #B-4333
3. Covers:
    a. Pedestal outlet: Hubbell #S-2425
    b. Duplex receptacle: Hubbell #S-3825
    c. Single system outlet: Hubbell #S-2625
4. Carpet Flanges:
    a. Single gang: Hubbell #S-3083
    b. Two gang: Hubbell #S-3084
    c. Three gang: Hubbell #S-3085

2.02 PULL BOXES

A. Sizes as indicated on the drawings and in no case of less size or material thickness than required by the governing code. Exercise care in locating underground pull boxes to avoid installation in drain water flow areas.
1. General purpose sheet steel pull boxes: Install only in dry protected locations with removable screw covers. Manufacturer's standard baked enamel finishes.

2. Weatherproof sheet steel pull boxes: Fabricate of code gauge, hot-dip galvanized steel with gasketed weathertight cover of same material. Manufacturer's standard baked exterior enamel finish.
3. Concrete pull boxes: Furnish complete with pulling irons, hot-dip galvanized traffic cover with hot-dip galvanized frame and 4 galvanized cable racks with porcelain blocks. The box to be set on a pea gravel base 12" thick and as large as the bottom. Install a 3/4" by 10' copper clad ground rod for grounding all metal parts. After cables have been pulled and inspected, seal box between cover and frame with a mastic compound similar to Parmagum or Dukseal. Construction equal to prefabricated pull boxes as manufactured by Jensen or Brooks Products. Refer to drawings for size. Box covers shall comply with Federal ADA, UL, State and Local AHJ for slip resistance. Provide bead weld on cover to pull box to indicate services within pull box (i.e., - "480/277-VOLT, 3-PHASE, 4-WIRE ELECTRICAL" OR "SIGNAL/TEL/P.A./CLOCK/FIRE ALARM").

2.03 SWITCHES

A. Provide circuit switches totally enclosed, Bakelite or composition base, toggle type with 277 volt A.C. rating for full capacity or contacts for incandescent or fluorescent lamp loads. Switch ratings shall be 20 ampere only. Color as selected by OWNER'S REPRESENTATIVE. Switches controlling circuits connected to emergency power shall be red.

B. Where switches are mounted in multiple gang assembly and are operating at 277 volts and/or 277 volts and 120 volts mounted in same outlet box, there shall be a barrier installed between each switch.

C. Switches

1. Single Pole Switches

Make	Toggle Type	Lock Type
Hubbell	#CS1221	#CS1221-L
P&S	#20AC1	#20AC1-L
Sierra	#5021	#5071
Leviton	#1221	#1221-L

2. Double Pole Switch

Make	Toggle Type	Lock Type
Hubbell	#CS1222	#CS1222-L
P&S	#20AC2	#20AC2-L
Sierra	#5022	#5072
Leviton	#1222	#1222-L

3. Three-Way Switches

Make	Toggle Type	Lock Type
Hubbell	#CS1223	#CS1223
P&S	#20AC3	#20AC3-L
Sierra	#5023	#5073-L
Leviton	#1223	#1223-L

4. Four-Way Switches

Make	Toggle Type	Lock Type
Hubbell	#CS1224	#CS1224-L
P&S	#20AC4	#20AC4-L
Sierra	#5024	#5074
Leviton	#1224	#1224-L

5. Momentary Contact Switches - 20A at 277V

	3-Position Req.	3-Position Lock
Hubbell	#1557	#1557-L
P&S	#1251	#1251-L
Sierra	#5120	#5170
Leviton	#1251	#1251-L

6. Maintained Contact Switches (Double Throw, Center Off), 20A at 277V

	Toggle Type		Lock Type	
Make	1-Pole	2-Pole	1-Pole	2-Pole
P&S	#1225	#1226	#12250L	#1226-L
Hubbell	#1385	#1386-L	#1385-L	#1386-L
Sierra	#5122	-----	#5175	-----
Leviton	#1385	#1386	#1385-L	#1386-L

7. Pilot lights used in conjunction with circuit switches shall be neon type with red jewel, P & S #437 (120 volt) or #438 (277 volt) or approved equal.

2.04 DIMMER SWITCHES

A. Dimmer switches shall be as indicated herein unless specifically noted otherwise on the drawings.

B. Dimmer cover plate shall be the same color as switch cover plates in the same area.

C. Dimmer switches shall be self-cooling and shall not require forced air cooling when individually or gang mounted. All dimmers shall be by the same manufacturer and the same appearance.

D. Dimmers shall include "RF" filters and is voltage stabilized.

E. Incandescent dimmers shall be used for control of line voltage incandescent light fixtures except "low voltage" type lights. Lutron "Maestro" series.
   1. Dimmer wattage shall be rated 2000 watt unless noted otherwise on the drawings.

F. Fluorescent dimmers, voltages as indicated on the drawings.
   1. Fluorescent dimmers (individual dimmers controlling less than 24 lamps per dimmer) Lutron "Maestro" series.
   2. Fluorescent dimmers (more than 24 lamps)
      a. Lutron #FDA-40 up to 40 lamps per controller.
      b. Lutron #FDA-80 up to 80 lamps per controller.
      c. Provide a minimum of 3-20 amp on all 120 volt units and on 277V 80 amp units.
      d. Control stations Lutron "Nova" series.
      e. Provide all material and labor for a complete and operable system.

G. Low voltage (transformer type) incandescent light dimmers shall be specifically designed for dimming low voltage light fixture transformers. Lutron "Maestro".

2.05 RECEPTACLES

A. All receptacles in flush type outlet boxes shall be installed with a bonding jumper to connect the box to the receptacle ground terminal. Grounding through the receptacle mounting straps is not acceptable. The bonding jumper shall be sized in accordance with the branch circuit protective device as tabulated herein under "Grounding". Bonding jumper shall be attached at each outlet to the back of the box using drilled and tapped holes and washer head screws 6-32 or larger (except isolated ground receptacles). For receptacles in

surface mounted outlet boxes direct metal-to-metal contact between receptacle mounting strap (if it is connected to the grounding contacts) and outlet box may be used. Color as selected by OWNER'S REPRESENTATIVE. Receptacles connected to emergency power circuits shall be red.

B. Duplex convenience receptacles shall be grounding type, 120 volt, 15 ampere, and shall have two current carrying contacts and one grounding contact which is internally connected to the frame. Outlet shall accommodate standard parallel blade cap and shall be side wired:
   1. P & S . . . . . #5262
   2. Leviton . . . . . .#5262
   3. Hubbell. . . . . #CR5252

C. Isolated Ground Receptacles
   1. The receptacle insulation barrier shall isolate the receptacle ground contact system from ground. Connect the ground plug contact to a separate dedicated insulated ground-bonding conductor. The receptacle ground plug contact shall not be grounded to the raceway or outlet box. Duplex convenience receptacle 20 amp minimum, with two current carrying contacts and one grounding contact, or as noted on the drawings.
   2. Identify receptacle with an orange triangle on the receptacle face and orange receptacle body. Red body for receptacles connected to emergency power.
      a. P & S IG6300
      b. Leviton 5362IG
      c. Hubbell CR5252IG

D. Receptacles shall be Underwriters Laboratories listed hospital grade.
   1. Duplex convenience receptacles shall be grounding type 120 volt 15 ampere with two current carrying contacts and one grounding contact which is internally connected to the frame. Outlets shall accommodate standard parallel blade cap and is side wired.
      a. P & S . . . . . # 9200HG
      b. Leviton . . . . . # 5262HG
      c. Hubbell . . . . . # 8200
      d. Woodhead . . . . . # 85262DW
   2. Duplex 20 ampere convenience outlets same as 15 ampere except ampacity shall be used where duplex receptacles is supplied by separate 20-ampere circuit:
      a. P & S . . . . . # 9300HG
      b. Leviton . . . . . # 5362HG
      c. Hubbell . . . . . # 8300
      d. Woodhead . . . . . # 85362DW
   3. Ground fault convenience receptacles provide separate ground fault receptacle at each location indicated on drawings.
      a. Leviton . . . . . # 6398HG
      b. Hubbell . . . . . # GF8300

E. Weatherproof receptacle: Ground fault type duplex receptacle, mounted in a flush hinged door enclosure with lock and key. Enclosure shall be a P & S #4600 with a #1591F46 receptacle. On exposed conduit runs, weatherproof ground fault type receptacle as hereinbefore specified, installed in "FS" condulet with one of the following spring door type covers:
   1. P & S . . . . . .#4510
   2. Hubbell . . . . . .#5211

F. Special outlets shall be as indicated on the drawings.

2.06 FLOOR OUTLETS

A. Flush duplex convenience receptacle in a cast iron floor box as hereinbefore specified shall be grounding type, 125 volts, 20 amperes, and shall have two current carrying contacts and one grounding contact which is internally connected to the frame. Receptacle shall be P & S or Hubbell #CR20, or Leviton #5014, with standard length mounting strap as required by the manufacturer of floor box being furnished.

B. Flush floor microphone and projector outlet shall be installed in a cast iron floor box as hereinbefore specified.

C. Pedestal type duplex convenience receptacle outlet shall be Walker-Parkersburg #513AL-DPS-G except with duplex grounding type receptacle (color as selected by OWNER'S REPRESENTATIVE) as hereinbefore specified. Unit shall be mounted on cast iron floor box as hereinafter specified with proper adapter and nipple for mounting to floor box.

D. Pedestal type telephone outlet shall be mounted on cast iron floor box as hereinbefore specified and shall be Walker-Parkersburg #407AL, #509AL, or #518AL telephone fitting, finished brush aluminum, complete with proper nipple and adapter for mounting to floor box. The CONTRACTOR shall install the type of outlet at each floor box location as hereinbefore specified as instructed by the Telephone Company engineers.

E. Pedestal type intercommunicating telephone, P.A. handset or buzzer system outlet shall be mounted on cast iron floor box as hereinbefore specified and shall be Walker-Parkersburg #501AL, cast aluminum, satin finish, with proper nipple and adapter for mounting to floor box.

F. Floor Boxes for Floor Outlets ("Poke-Thru").
   1. Through floor wiring for power and communication shall be UL listed with a fire rating of 4 hours. The units shall include a divided floor pedestal, a divided through-floor conduit/raceway, and a divided underfloor junction box not less than 4.7 x 4.7 x 2.125-inches in size. Junction box shall be installed concealed in ceiling space of the floor below. The length of the floor "through-raceway" shall match the thickness of the finish floor and as recommended by the manufacturer. Unit shall be self-supporting without the attachment of an above floor fitting. The integral fire barrier shall incorporate a cold smoke barrier to prevent the passage of smoke when heat is not present. As manufactured by Hubbell Fire Rated Poke-Through fittings.
   2. Floor pedestal (internally divided high potential and low potential sections) service fittings die cast, brushed aluminum, single piece device housing, with stainless steel device cover plates front and rear of the housing as follows:
      a. Front side - 20 ampere, 120 volt, 60 HZ, AC, duplex convenience outlet plugs.
      b. Rear side - knockouts for signal cables (1) -1" diameter and (2) - 3/8" diameter with rubber bushing grommets for each knockout.
      c. Alternately where specifically indicated on the drawings, the front and rear cover plates shall be supplied with knockouts for 3/4" flexible conduit connection, one per cover plate.

2.07 PLATES

Provide plates for every switch, receptacle, telephone, computer, television and other device outlets. All plates shall be smooth finished thermoplastic, color as selected by Architect. Plates shall be manufactured by P & S, Hubbell, Leviton or General Electric only.

2.08 STRUCTURAL AND MISCELLANEOUS STEEL

Structural and miscellaneous steel used in connection with electrical work and located out-of-doors or in damp locations, to be hot-dip galvanized unless otherwise specified. Included are underground pull box covers and similar electrical items. Galvanizing averages 2.0 ounce per square foot and conforms to ASTM A123.

2.09 FLASHING ASSEMBLIES

Provide Semco Fig. #1100-4 non-lead metal flashing assemblies at all roof penetrations. Seal the joint between flashing and pipe with waterproofing compound.

2.10 RELAYS, CONTACTORS, AND TIMESWITCHES

A. Individual Control Relays (HV/AC Plumbing of the Control Functions)

1. Individual control relays shall have convertible contacts rated a minimum of 10 amperes, 600 volts regardless of usage voltage. Coil voltage, number and type of contacts shall be verified and supplied to suit the specific usage as shown in the wiring diagrams and/or schedules on the electrical and mechanical drawings. Coil control circuit shall be independently fused, sized to protect coil. Relays shall be installed on prefabricated mounting strips. Each relay shall have a surge suppressor to limit coil transient voltages. Furnished in the NEMA Type I enclosure unless indicated otherwise.
2. The following relays are approved:

Manufacturer	Type
Arrow Hart	IMP
General Electric	Class CR 2811
I.T.E.	Class J10
Square D Co.	Class 8501, Type A
Westinghouse	Bul. 16-321, Type NH
Allen Bradley	Approved Equal

B. Contactors and/or Relays

1. Contactors and/or relays for control of lighting shall be 600 volt A.C., electrically operated, mechanically held units, open type for panel mounting with number of poles and of size as indicated on the drawings. Provide auxiliary control relay for operation of each contactor and/or relay with a two-wire control circuit.
2. Contactors and/or relays shall be mounted in panelboards in barriered section under separate hinged lockable doors or in contactor and/or relay cabinets as called for on the drawings. Contactors and/or relays shall be installed on Lord sound absorbing rubber mounts.
3. Contactors and/or relays shall be Automatic Switch Co. Bulletin #920 Series for 2 and 3 pole, Automatic Switch Co. Bulletin 917 Series with poles as indicated on drawings. Coil control circuit shall be independently fused, sized to protect coil.
4. Contactors and/or relays shall be equipped with a switch, in the proper configuration, to disconnect the control circuit controlling the coil of the respective device. Control circuit disconnect switch shall be labeled showing function of device.

C. Timeswitches

1. All timeswitches shall have synchronous motor drive for operation on 120 or 277 volts, 60 Hertz, A.C. and shall be furnished with a ten-hour, spring-driven, reserve-power motor. Contacts shall be rated 40A per pole.

a. Exterior lighting timeswitches for control of individual circuits or electrically operated relays shall have astronomic dial and shall be Tork 7000ZL Series or approved equal by Paragon or Intermatic.
b. Interior lighting timeswitches for control of individual circuits or electrically operated relays shall be Tork 7000 Series or approved equal by Paragon or Intermatic.
c. Timeswitches for control of air conditioning or plumbing equipment shall have seven day dial and shall be Tork WL Series or approved equal by Paragon or Intermatic.

2. All timeswitches shall be mounted in separate section in top of panelboards under separate lockable door unless otherwise indicated on drawings. Clear opening for timeswitch shall be a minimum of 12" x 12".

D. Contactors and/or Relays/Timeswitch Cabinet

1. Contactors, relays, and/or timeswitches not indicated to be mounted in electrical panels shall be mounted in a cabinet, size as required, with hinged lockable door keyed same as panelboards. Construction of cabinet shall be similar to terminal cabinets.
2. Each contactor, relay or timeswitch mounted in the contactor cabinet shall be barriered in its own compartment, and shall be installed on Lord sound absorbing mounts.
3. Contactor cabinets shall be of the same manufacturer as the panelboards.
4. Where relays and/or contactors occupy the same enclosure as timeswitches they shall have a clear acrylic shield installed over each relay or contactor to guard line exposed parts from accidental contact by nonauthorized personnel.

2.11 DISCONNECTS (SAFETY SWITCHES)

Disconnect switches shall be rated 600 volt A.C., NEMA Type HD, quick-make, quick-break, h.p.-rated, fused Class "R", in NEMA Type I enclosure, lockable with number of poles and amperage as indicated on the drawings. Provide neutral bus and conductor landing lugs, size to match conductors shown on drawings. Where enclosure is indicated W.P. (weatherproof) switches shall be raintight NEMA Type 3R enclosure, lockable. Maximum voltage, current and horsepower rating clearly marked on the switch enclosure and switches having dual element fuses shall have rating indicated on the nameplate.

2.12 TRANSFORMERS

A. General

1. Provide dry type transformers constructed to meet Underwriters' Laboratories Specification UL 506 and tested in accordance with USAS I and NEMA Standards. Performance on transformers equal to or better than ANSI, NEMA, IEEE and N.E.C. published criteria.
2. UL Class 220°C insulation with maximum winding temperature rise of 150°C in 40°C ambient at 100% continuous rated capacity with overload capacity per ANSI C57.12 and C57.96. Transformer efficiency shall meet or exceed NEMA-TP1 (latest revision) requirements.
3. Transformers shall be equipped with five 2.5 percent full capacity voltage taps, two (2) above and three (3) below normal voltage. Line and load terminals shall be accessible, located behind removable front cover plate.
4. Transformers Manufactured by Westinghouse, General Electric, Square D Co., or Siemens.
5. Transformers mounted per Korfund Literature for weight of transformer. Connect transformers by one of the following methods:
   a. Underfloor conduit resulting in no rigid connections to transformer. (Use ground strap for equipment ground.)

b. Sealtite flexible conduit. (Use ground wire for equipment ground.)
c. Pullbox or wireways from transformer which are isolated from transformer with an approved sound absorbing neoprene gasket. (Use ground strap for equipment ground.)

6. The physical dimensions of the transformer, shall not exceed the size shown on the drawings.

B. Bolt floor-mounted transformers to floor using isolation rubber mount, on each floor contact location.

C. Test Requirements: The transformers furnished to this specification shall be subjected to the following production tests:
1. Applied Potential
2. Induced Potential
3. No Load Loss.
4. Voltage Ratio.
5. Polarity
6. Continuity

D. Transformer Housing
1. Removable metal NEMA 1 enclosure, with screen protected ventilation for all openings, including bottom of housing.
2. Manufactures standard finish paint.
3. Removable lifting and skidding provisions.

E. The manufacturer shall have performed the following additional tests on units identical to the design type being supplied to this specification. Proof of performance of these tests in the form of test data sheets shall be provided at the time shop drawings are submitted for approval.
1. Sound Levels
2. Temperature
3. Full Load and 50 Percent Load Losses
4. Voltage Regulation
5. Impedance
6. Dry type transformers shall meet or exceed NEMA TP-1 (latest revision), Class-1 efficiency levels and shall be marked as energy efficient for United States Department of Energy and Environmental Protection Agency DOE/EPA Energy Star.

F. Sound Levels: Transformer sound levels, between no load to full load, shall be guaranteed by the manufacturer not to exceed the following values:

9 kVA and below	40 dba
10 kVA to 50 kVA	45 dba
51 kVA to 150 kVA	50 dba
151 kVA to 300 kVA	55 dba
301 kVA to 500 kVA	60 dba

G. Transformer windings shall be copper only.

H. Electrostatic Shield: Provide full width, copper, 100% electrostatic shield (Faraday Shield), between line and load transformer windings, on each transformer phase. Shield shall be low impedance grounded to the transformer metal frame and shall attenuate common mode electrical noise 120dB at 1-500Mhz range and transverse mode electrical noise. 30dB at 1-500 Mhz range. Average effective coupling capacitance of 30 picofarads between line and load sides.

I. Transformer shall be rated K4, for harmonic content electrical loads, in accordance with UL156/and IEEE C57.110 (latest revision). The transformers shall be specially designed and manufactured for non-linear electrical load which cause harmonic current and voltage distortion, with 3rd, 5th, 7th, 9th and 15th harmonic current and voltage distortion. Transformers, which are simply oversized larger than the specified kVA rating and then derated to the specified KVA rating to compensate for harmonic overloading, are not acceptable.

2.13 SPARE FUSE CABINETS

Provide a cabinet in each room where a switchboard or motor control center is installed and contains fuses. Cabinets shall be as specified for "Terminal Cabinets" and shall be of sufficient size to contain all spare fuses hereinbefore specified. Provide clips (2 per fuse) for each spare fuse. Mount clips in plywood backboard in cabinet. Label cabinet "SPARE FUSES".

2.14 CONCRETE WORK

A. Portland Cement
   1. ASTM C33-67, Type II, Low Alkali Cement. Composed of Portland cement, coarse aggregate, fine aggregate, and water.
      a. Concrete for use as electrical equipment footings, lighting pole bases and equipment slabs on grade, concrete shall attain minimum 28 day compressive strength of 4000 psi, using not less than 5 sacks of cement per cu. yd. of wet concrete.
      b. Concrete for underground duct/conduit encasement, the minimum 28 day compressive strength shall be 2000 psi. Provide a minimum of (10) ten pounds of red oxide concrete coloring per yard of concrete.
      c. Mix shall obtain a 6" slump, measured with standard slump cone per ASTM C145-58.
   2. Coarse Aggregate: Uniformly graded between maximum size not over 1-1/2" and not less then 3/4" and minimum size #4, crushed rock or washed gravel. For concrete encased conduit only, maximum aggregate size shall be 1/2".
   3. Fine Aggregate: Clean, natural washed sand of hard and durable particles varying from fine to particles passing 3/8" screen, of which at least 12% shall pass 50 mesh screen.

B. Water: Clean and free from deleterious quantities of acids, alkalis, salts, or organic materials.

C. Reinforcement
   1. Bars: Intermediate Grade Steel conforming to ASTM A15-66, with deformations conforming to ASTM A305-65, except #2 bars shall be plain.
   2. Welded Wire Fabric: ASTM A185-64.
   3. Bending: Conform to requirements of ACI 318-63.

D. Form Material: For exposed work, use PS 1-66 "B-B Concrete Form" plywood forms, or equal. Elsewhere, forms may be plywood, metal, or 1" x 6" boards. Forms for round lighting pole bases shall be sono-tube.

2.15 TRANSIENT VOLTAGE SURGE PROTECTOR (TVSS)

A. General
   1. The unit shall be modular in construction and operate in parallel with 60 H.Z. A.C. line voltage, four (4) wire or five (5) wire, grounded or ungrounded systems, as applicable; voltage, KVA and ampere capacity as indicated on the drawings. Suitable for connection through a external circuit breaker or combination switch/fuse

protective device rated 30 ampere, continuous duty, rated for Service Entrance equipment connection.

2. The unit shall operate correctly with any combination of resistive, inductive, or capacitate loads. The unit shall automatically shunt to ground the electrical transients and EMI/RFI noise occurring above the specified values. The unit shall automatically reset after transient condition has passed. Operating temperature - 40° centigrade to 85° centigrade.
3. Provide one or more individual self-contained protection module(s) for each line voltage phase, plug-in type. Provide one spare individual plug-in protection module. Provide incoming line, neutral and ground conductor termination lugs rated CU/AL #14 thru #4 AWG. Lugs shall be barriered from and prewired to the respective protection modules.
4. Provide a NEMA 12 housing to contain all unit modules, devices and conductor terminations. The housing shall include a hinged padlockable door. Surface mounted, with conduit entrance knockouts. Maximum housing size shall not exceed 36" wide x 72" high x 8" deep.
5. As manufactured by EFI Corporation Model #MXPB/TVSS; MCG Electronics; Current Technology; Liebert or equal.

B. Operational Characteristics

1. Transient voltage protection, testing, listing and certification.
   a. UL 1449 (latest edition) and CSA, for Transient Voltage Surge Suppresser, UL 1283 for transient voltage electrical noise attenuation, ANSI/IEEE C62.45, C62.1 for C62.41, (latest edition) transient clamping voltages for both Normal Mode and Common Modes against Category A & B ring wave and Category B impulse wave.
   b. The unit connected to the service entrance shall also withstand a minimum of 1000 sequential ANSI/IEEE C62.41 Category C surges without failure following IEEE test procedures in C62.1, C62.41 and C62.45.
2. Transient voltage protection, EMI noise rejection, and RFI noise rejection shall be provided for Common Mode (line-to-neutral), Normal Mode (line-to-line) and neutral to ground.
3. EMI and RFI noise rejection.
   Conducted line noises interference both electromagnetic (EMI) and radio frequency (RFI) shall be reduced by the unit over a continuous spectrum of 0.5 MHZ to 1.0 MHZ. The basis for reduction shall be a standardized 50-OHM insertion loss MIL - STD-220A test. Provide spectrum analysis test dB attenuation reports showing RFI filtering over specified frequencies. Test data based on calculated or computer simulation is not acceptable.
4. Three phase and grounded "WYE" performance requirements.

Characteristics	208/120 Volt	480/277 Volt
Nominal line to line	208 Volt	480 Volt
Nominal line to neutral	120 Volt	277 Volt
Internal capacitance (Microfarads)	2.5	2.5
Maximum response time	1-nanosecond	1-nanosecond
EMI/RFI noise rejection	25-35DB	25-35-DB
Nominal peak clamp voltage Line to neutral and line to ground		

	205 Volts	330 Volts
Minimum transient energy dissipation per phase (at 8 x 20 microseconds waveform)	1000 Joules	1500 Joules
Peak transient withstand (at 8 x 20 microseconds waveform) without failure of the unit		
	50,000 Amp	60,000 Amp
a. Category-C3	80,000 Amp	100,000 Amp
b. Category-B3	60,000 Amp	80,000 Amp
c. Category-A3	50,000 Amp	60,000 Amp

C. Diagnostic Indicators
1. Shall display the "Normal" and "Fault" status of each line suppression circuit, along with protection circuit "on" indication.
2. Shall provide a sonic audible fault alarm with silence push-button.

D. Surge Suppressor Protection Categories
1. Surge protectors shall comply with ANSI C62.41 (Latest Revision) Standard Protection Categories for "impulse" and "ringwave" transients, based on the installation locations shown in the contract documents.
   a. Service entrance, main switchboard or substation locations - Category "C3", high exposure.
   b. Mid building, distribution panels, distribution panels over 400 ampere main bus rating locations - Category "B3", high exposure.
   c. Branch circuit panelboards 400 ampere or less main bus rating - Category "A3", high exposure.
2. The TVSS short circuit current withstand rating shall exceed the actual short circuit current available at the TVSS installation location

2.16 WIREWAY

A. General

Unobstructed lay in type, metal wireway, fittings and connectors UL listed for use as wireway and auxiliary gutter. Length, elbows and "T-S" as shown on drawings. Minimum cross-section size 4 inches X 4 inches, but not less then shown on the drawings. Suitable for mounting in any position orientation.

B. Construction
1. Minimum metal gauge shall not be less then 14 gage.
2. Cover shall be hinged entire length of cover. Cover shall be held in the closed position with bolts and nuts.
3. Provide spring nuts on all hardware fastener penetrations into the interior of the wireway to protect against wire insulation damage.
4. The inside of 90-degree corners in the wireway shall be a 45-degree bevel.
5. Grounding continuity between wireway sections and fittings shall be continuous the entire length of the wireway.

C. Finish
1. Indoor non-raintight, rust inhibitor phosphatizing base coating and baked enamel finish, manufacturer's standard color.
2. Raintight or outdoor-galvanized metal, with corrosion resistant phosphate primer and baked enamel finish, manufacturer's standard color, Nema 3R construction.
3. All hardware shall be plated to prevent corrosion.

PART 3 - EXECUTION

3.01 GROUNDING (ADDITIONAL REQUIREMENTS)

A. Grounding shall be executed in accordance with all applicable codes and regulations, both of the State of California and local authorities having jurisdiction.

B. The neutral of each transformer shall be grounded by individual separate ground conductors in individual conduits as follows:
   1. Conductor and conduit shall be grounded to building main ground bus.
   2. Conductor and conduit shall be grounded to nearest available effectively grounded building structural steel member or grounded metal cold water pipe.

C. The transformer neutral ground conductors for secondary side of the transformers shall be copper and shall be sized according to the following table:

Secondary Total Equivalent Size Copper	Neutral Ground Wire Size Copper
#2 or smaller	#6-1" conduit
1 or 1/0	#4-1" conduit
2/0 or 3/0	#2-1 1/4" conduit
4/0 thru 350 MCM	#1-1 1/4" conduit
Over 350 MCM thru 600 MCM	2/0-1 1/2" conduit
Over 600 MCM thru 1100 MCM	3/0-1 1/2" conduit
Over 1100 MCM	4/0-2" conduit

D. Each pull box or any other enclosure in which several ground wires are terminated shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall have a separate lug for each ground conductor. No more than one conductor shall be installed per lug.

E. The maximum resistance to ground shall not exceed 5 ohms.

3.02 OUTLET AND JUNCTION BOXES

A. Accurately place boxes and securely fastens to structural members. Where outlets are shown at same location but at different mounting heights, install outlets in one vertical line. Where outlets are shown at same location and mounting height, mount outlets as close together in a horizontal row as possible. Where the outlet boxes for switches and receptacles are shown at the same location and mounting height, mount in common outlet box with barriers between devices. Provide single piece multigang cover plate for close mounted outlet boxes. Where switches are shown on wall adjacent to hinge side of doors, box shall be installed to clear door when door is fully opened.

B. Flush mounted boxes shall be attached to two studs or structure members by means of metal supports.

C. Boxes above accessible ceilings shall be attached to structural members. Where boxes are suspended, they shall be supported independently of conduit system by means of hanger rods and/or preformed steel channels. Boxes shall be supported independently of all piping, ductwork, equipment, ceiling hanger wires and suspended ceiling grid system.

D. Surface mounted outlets shall be attached to concrete or masonry walls by means of expansion shields.

E. Floor boxes shall be installed level with finish floor and within adjustable limits of floor ring. Where outlets are shown at same or adjacent location, use multigang boxes.

F. Outlet Box Horizontal and Vertical Separation: Outlet boxes and device outlet rings installed flush in walls shall be horizontally and vertically separated by not less than 24 inches (edge of box to edge of box) from device outlet boxes and rings in common wall surfaces located on the opposite (back) side of the same wall.
   1. Where the separation cannot be maintained, provide a solid backing behind and completely enclosing each outlet box.
   2. The backing shall extend the width of the wall cavity (i.e., between "studs" or masonry cells) behind the box and 12 inches above and below the outlet box centerline, completely enclosing the outlet box.
   3. The backing shall consist of the following:
      a. 5/8 inch thick gypsum board anchored in place for "stud" wall construction.
      b. Solid "mortar" to completely fill the outlet box "cell" behind the box in masonry construction.

G. In fire rated walls and ceilings provide fire rated "box-wrap" around the outside of each outlet box placed in fire rated wall or ceiling inside the wall, to maintain the fire rating of wall with the installed outlet boxes.

H. Plug-In Type Receptacle Installation Orientation
   1. The "ground-pin" shall face "up" at the receptacle top location (double duplex) 4-plex, individual and vertically mounted individual duplex receptacles.
   2. The "neutral-blade" shall face "up" at the receptacle top location on horizontally mounted duplex receptacles.

3.03 CONCRETE WORK

A. Form
   1. Space forms properly with spreaders and securely tie together. Do not use twisted wire form ties. Keep forms wet to prevent joints from opening up before concrete is placed. Replace improper construction as directed. Do not use wood inside forms.
   2. Build in and set all anchors, dowels, bolts, sleeves, iron frames, expansion joints and other materials required for the Electrical Work. Place all items carefully, true, straight, plumb, and even.
   3. Carefully remove all exposed forms. Cut nails and tie wires below face of concrete and fill all holes. Rubbish will not be allowed to remain in, under, or around concrete.

B. Mixing: Use batch machine mixer of approved type. After ingredients are in mixer, mix for at least 1-1/2 minutes.

C. Transit Mixing: In lieu of mixing at site, transit mixing may be used if rate of delivery, haul time, mixing time, and hopper capacity is such that concrete delivered will be placed in forms within 90 minutes from time of introduction of cement and water to mixer.

D. Placing of Concrete
   1. Before placing concrete, remove wood, rubbish, vegetable matter and loose material from inside forms. Thoroughly wet down wood forms to close joints.
   2. Clean reinforcement, remove paint, loose rust, scale and foreign material. Bars with bends not called for will be rejected. Hold securely in place to prevent displacement. Lap bar splices 24 diameters, min; lap fabric one mesh min. Tie intersections, corners, splices with 16 ga.-annealed wire, or as otherwise called for.

3. Place concrete immediately after mixing. Do not use concrete that has begun to set; no tempering will be allowed. If chuting is used, avoid segregation. In placing new concrete against existing concrete, use bonding agent per manufacturer's directions.
4. Give careful and thorough attention to curing of concrete. Keep concrete and forms wet for a minimum of 10 days, after placing concrete.

E. Concrete Finish
1. Finish of Exposed Concrete: Horizontal surfaces, steel troweled monolithic finish; vertical surfaces, smooth and free of fins, holes, projection, etc.
2. Exposed lighting pole bases shall be filled and sack finished to a smooth finish.

3.04 TRANSIENT SURGE PROTECTOR INSTALLATION (TVSS)

A. Installation
1. Install unit cabinet to insure a maximum connected circuit length of less than 8 feet from the equipment the transient surge unit is connected to, approximately +48" on wall.
2. Install TVSS inside switchgear, switchboards, panelboards, etc. where shown on the drawings.
3. Connect between transient surge unit and supply equipment with not less than 1 1/4" conduit containing 5#4 AWG, copper conductor, 600 volt THHN/THWN insulation, connection circuit.

B. Install, connect and test unit in accordance with manufacturer's recommendations.

C. Connect transient surge unit to main building ground bus with 1 1/4"C - 1#2 AWG copper conductor 600 volt, THHN/THWN insulation.

D. Provide a subfeed overcurrent protective device in the respective panel or switchboard to supply the TVSS connection circuit, whether or not shown on the drawings. The protective subfeed device shall be a thermal magnetic circuit breaker rated not less than 30 ampere - 3 pole or a safety switch and fuse unit rated not less than 60 ampere - 3 pole, voltage and short circuit interrupting class to match the respective circuit voltage.

3.05 WIREWAY INSTALLATION

Wireway hangers shall provide clamp type, hanger rod type, direct bolted bracket type from ceiling or walls as indicated on the drawings and required for field installation locations. Supports shall be installed a minimum of 5 ft. on center.

END OF SECTION