Scope of Work

Site Work CTE Project – Glendale HS – Bid No. 191-18/19

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SUMMARY OF THE WORK

PART 1 - GENERAL

1.01

1. The furnishing of all labor, materials, equipment, services, and transportation of Glendale High School CTE Equipment Power at 1440 East Broadway, Glendale, CA 91205, as set forth in the Contraction Documents which is required for the completion of the project in accordance with the provisions of the contract

2 Article 3 of the Bid General Conditions requires preparation of a Cost-loaded time logic schedule with a single critical path. If the Board approved lowest responsive and responsible bid Contractor and the Project Manager, on behalf of the District, cannot agree on the contract construction schedule and the project single critical path within fifteen (15) days after Notice to Proceed, the District may terminate the Contract, for convenience, as outlined in the Project General Conditions. In the event this is necessary, compensation to the General Contractor and all subcontractors or materialmen shall be limited to Mobilization costs only.

3. The liquidated damages shown in the Supplementary General Conditions shall apply to each phase of the phased construction plan, as defined by and within the plans and specifications.

4 No warranties or guarantees shall go into effect, for any trade, regardless of when completed in the sequence of the project erection, until one (1) day after the Board of Education has accepted the project at a noticed meeting. Attention: Bidders. This will require certain trades to bid for, and provide, a warranty of longer than one (1) year in length from the time of installation or furnishing of their materials to the project, depending upon the sequencing of their work within the overall schedule.

5 All project close-out/punch list items, project record documents, submittals, and operations manuals and spare parts, warranties and guarantees and Contractor's Final Verified Report (DSA6) shall be reviewed and accepted prior to the Architect/District agreed upon authorization to file the Notice of Completion with the Los Angeles County Recorder.

6 In the event that any materials requiring DSA Inspection (steel, concrete, masonry grout, etc.) are manufactured in an area located more than one hundred miles (100 miles) by air radius from the project site, all round-trip travel and all per diem costs incurred by the District on behalf of the Deputy Inspector who must perform on-site examination of the materials shall be borne 100% by the Contractor as an added expense. This charge shall be subtracted from the monthly "Application for Payment" submitted to the District on behalf of the project.

7 In the event the General Contractor or any subcontractor or materialman (on or off site) voluntarily accelerates the schedule for their own purposes, and/or voluntarily performs work in excess of eight (8) hours per day, or on the weekends or holidays, the additional cost of the Inspectors' overtime premiums which are required to inspect the work during these hours shall be paid 100% by the Contractor. This charge shall also be subtracted from the monthly "Application for Payment" submitted to the District on behalf of the project.

8 In the event that the Contractor fails to complete all punch list items and turn over all "deliverables, warranties, As-builts, etc." within sixty (60) days after acceptance of completion by the Board of Education, the full salary costs of one (1) construction Project Manager (16 hours per week @ $120.00/hour) and one DSA Inspector of record (actual hours spent @$80.00/hour) shall be back-charged to the Contractor, in addition to the liquidated damages, if any, imposed upon the Contractor for late performance. THIS PARAGRAPH WILL BE STRICTLY ENFORCED.

9. The intent of these contract documents is that the work of alteration, rehabilitation or construction is to be accordance with Title 24, California Code of Regulations. Should any existing conditions such as deterioration or non-complying construction be discovered which is not covered by the Contract Documents wherein the finished work will not comply with Title 24, California Code of Regulations, a change order, or a separate set of plans and specifications, detailing and specifying the required repair work shall be submitted to and approved by DSA before proceeding with the repair work.

a.

RELATED SECTIONS

PART 2 – SCOPE OF WORK

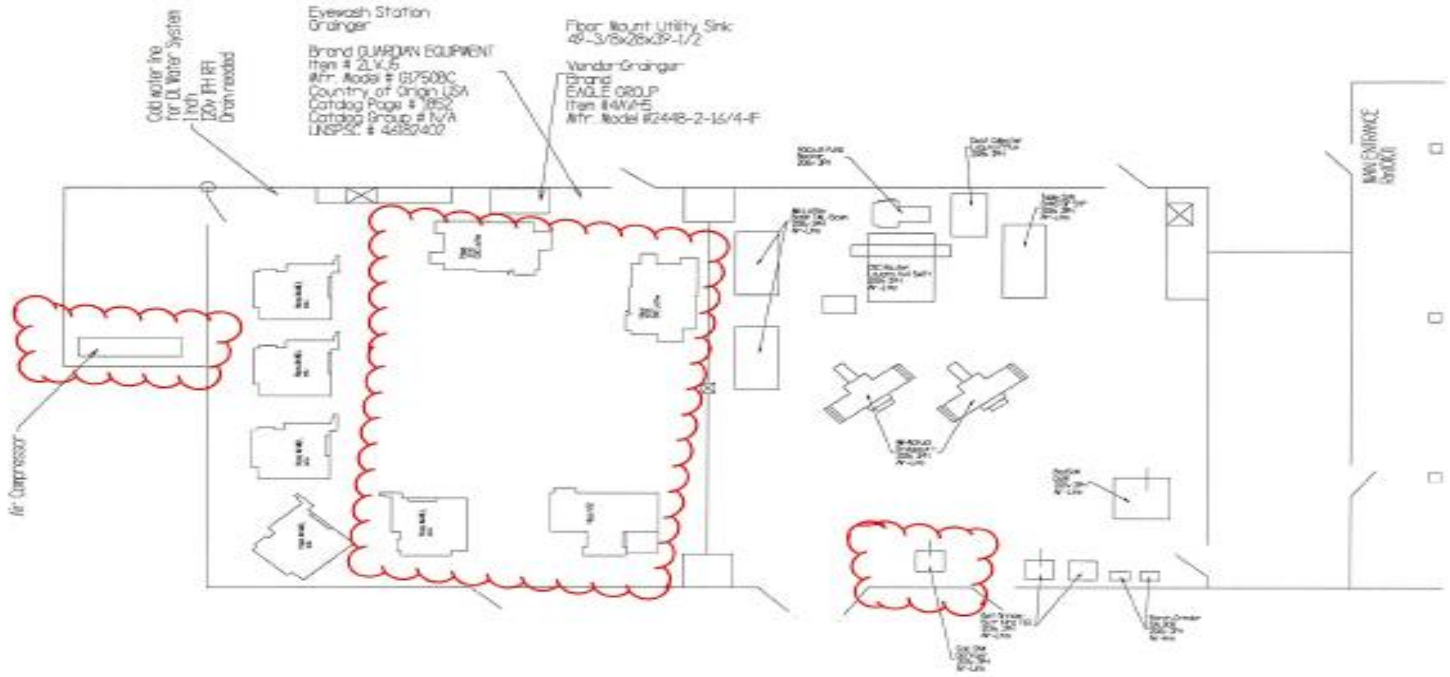
2.01

A. Scope of Work: Contractor shall perform, within the time stipulated, the Contract including all of its component parts, and everything required to be performed, and to provide and furnish any and all of the labor, materials, tools, expendable equipment, and all applicable taxes, and all utility and transportation services necessary to perform the Contract and complete, in a workmanlike manner, all of the Work required in connection with the following titled Project in strict conformity with the Contract Documents:

2.02 A. Glendale High School at 1440 East Broadway, Glendale, CA 91205

A. Glendale High School 10000 Building Electrical for equipment.
1. Provide a 400 amp electrical Commercial breaker panel
2. Provide a 2.5 inch conduit from the electrical room to new transformer and breaker panel in the air compressor room
3. Wires are to be (3) 2/0 cables from electrical room
4. Contractor is to provide all new breakers for panel and a new breaker in the electrical room with all the necessary hardware and also provide a new cover for the breaker in the electrical room
5. Contractor is responsible for providing transformer
6. Contractor is to furnish all wires and hardware and connections necessary to complete the project
7. Contractor is to connect all machines based on the provided plans and drawings in the next two pages
8. Install all high voltage necessary electrical for each equipment unit provided on the drawing and label
9. Contractor is to connect the units with a ridged piping down the ceiling and connect to the machines with seal tight flex (must have metal Jacket inside of seal tight flex)
10. All machines must be grounded properly
11. Name and Tag every unit with ID and breaker number and ID the unit on the Breaker Panel
12. Contractor is responsible of all clean up and disposal of items resulting from work.

13. Contractor is responsible to do all of t-bar ceiling modification or damages
14. Contractor is responsible for any coring if necessary
15. Contractor is responsible for all patching providing fire caulking at all penetration though walls
16. Contractor is to provide their own disposal and are not allowed to use district trash bins
17. Contractor is responsible for moving all furniture in classroom and relocating back to original location
18. Must clean entire work area and job site and have ready for occupancy.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Grainger
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Mfr. Model # G1750BC
Country of Origin USA
Catalog Page # 1852
Catalog Group # 1VA
UNSPSC # 46182402
Floor Mount Utility Sink
49-3/8x28x37-1/2
Vendor Grainger
Brand
ENGLE GROUP
Item #4MVA5
Mfr. Model #2448-2-16/4-F
Cold water line
for DI Water System
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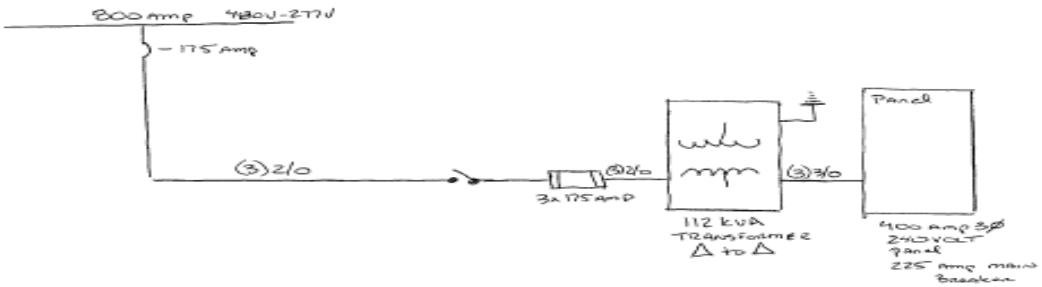
120v 1PH 1Ø1
Drain needed
Air Compressor
MAIN ENTRANCE


Y
X

110.2355 in


800 amp 480V-277V
175 amp
3 #2/0
3 #2/0
3 #175 amp
112 kVA
TRANSFORMER
Δ to Δ
3 #3/0
Panel
400 amp 3Ø
240 VOLT
panel
225 amp main
breaker

SECTION 26
05 00
COMMON WORK RESULTS FOR
ELECTRICAL

NOTE TO ARCHITECT/PROJECT MANAGER: 1.21 Need Values for each project

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. Electrical General Provisions and requirements for electrical work.
   3. Division-1; General Requirements; General Conditions.

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 District'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, furniture, cabinets, 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 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. Detection/location 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 and prior to directional boring the following work shall be performed:
    a. Contractor to mark excavating and trenching/ directional boring 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 District'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, both 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 three (3) meters below finish grade and located with a vertical and horizontal accuracy within ± 12-inches of actual condition. The Contractor shall add this information to the existing conditions site plan.

3. Exercise extreme caution in directional boring, excavating and trenching on this site to avoid existing underground utilities and structures, and to prevent hazard to personnel and/or damage to existing underground utilities or structures. The contract documents, 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 District any existing work damaged that was identified in the record drawings provided; Identified by the District'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 Common Ground Alliance (CGA) telephone #811 "Know What's Below-Call Before You Dig" and Underground Service Alert (USA), not less than 72- hours prior to excavation. Contractor shall not excavate until verification has been received from CGA and USA that existing underground utilities serving the site have been located, identified, and marked.

H. The locations of existing underground utilities, where shown on drawings, are shown diagrammatically and have not been independently verified by the District, the District's Representative, the Architect/Engineer. The District, the District's Representative, and the District'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 DISTRICT. Service information will be furnished by the serving utilities. Comply with requirements of the DISTRICT'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 DISTRICT'S Representative or A/E for review. Copies of the serving Electrical Utility approval of the equipment shall be included in the shop drawings submittals to the DISTRICT'S Representative and A/E.

1.06 PERMITS

Take out and pay for all required permits, inspections and examinations without additional cost to the DISTRICT.

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. California Fire Code – CFC

5. The National Electrical Code – NEC/NFPA 70.
6. The Life Safety Code – NFPA 101.
7. The Uniform Building Code - UBC.
8. International Building Code – IBC.
9. National Fire Protection Agency-NFPA.
10. National Fire Alarm Code – NFAC/NFPA 72.
11. Underwriter's Laboratory-UL.
12. Other applicable State and Local Government Agencies laws and regulations.
13. 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-104: Recommended Practice for Installing Aluminum Building Wire and Cable
    d. NECA/NEIS-105: Recommended Practice Installing Metal Cable Trays
    e. NECA/NEIS-111: Recommended Practice Installing Nonmetallic Raceways
    f. NECA/NEIS-230: Recommended Practice for Installing Motors
    g. NECA/FOA-301: Standards for Installing and Testing Fiber Optic Cables
    h. NECA/NEIS-305: Standard for Fire Alarm System Job Practice
    i. NECA/NEIS–331: Standards for Installing Building and Service Entrance Grounding
    j. NECA/NEIS-400: Recommended Practice for Installing and Maintaining Switchboards k. NECA/NEIS-402: Recommended Practice for Installing and Maintaining Motor Control Centers
    l. NEIS/NECA and EGSA-404: Recommended Practice for installing Generator Sets
    m. NECA/NEIS-405: Recommended Practices for installing and Commissioning Interconnected Generation Systems
    n. NECA/NEIS-407: Recommended Practice for Installing Panelboards
    o. NECA/NEIS-408: Recommended Practices for Installing Busway
    p. NECA/NEIS-409: Recommended Practice for Installing and Maintaining Dry-Type Transformers
    q. NEIS/NECA and IESNA-500: Recommended Practice for Installing indoor Commercial Lighting Systems
    r. NEIS/NECA and IESNA-501: Recommended Practice for Installing Exterior Lighting Systems
    s. NEIS and IESNA-502: Recommended Practice for Installing Industrial Lighting Systems
    t. NECA/BICSI-568: Standards for Installing Commercial Building Telecommunications System
    u. NECA/NEIS-600: Recommended Practice Installing Medium-Voltage Cable

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 (ADDITIONAL REQUIREMENTS)

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 DISTRICT 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 not 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 within 35 days of award of contract. 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-inches by 17-inches or smaller in size shall be bound in three (3) ring binders. Divider tabs shall be provided in the three (3) ring binders identifying and separating each separate shop drawing submittal item. Shop drawings larger than 11-inches by 17-inches, shop drawing pages/sheets submittals shall be sequentially numbered with unique alphanumeric numbering system to facilitate correspondence referencing identification of individual sheets.
5. The time required to review and comment on the CONTRACTOR'S submittals will not be less than 14 calendar days, after receipt of the submittals at the office of FBA Engineering. The review of CONTRACTOR submittals and return to CONTRACTOR of submittals with review comments will occur in a timely manner conditioned upon the CONTRACTOR complying with all of the following:
   a. The submittals contain complete and accurate information, complying with the requirements of the Contract Documents.
   b. CONTRACTOR'S submittals are each marked with CONTRACTOR'S approval "stamp", and with CONTRACTOR signatures.
   c. The submittals are received in accordance with a written, shop drawing submittal schedule for each submittal. The CONTRACTOR distributes the schedule not less than 35-calendar days in advance of the Shop Drawing Submittals, and the schedule identifies the calendar dates, the CONTRACTOR will deliver the various submittals for review.
6. 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 District's Representative of any changes in delivery, which would affect the project completion date.
7. 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. Contractor shall provide a written response narrative with each resubmittal. Describe each response-action, resubmittal addition, change and deletion. Correspond each response to A/E specific review comment.

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. The CONTRACTOR shall pay, upon request by the District's Representative, a fee for the District's Representative time involved in the review of substitution submittals and design changes resulting from the CONTRACTOR'S requested substitutions. The fee shall be not less than $125.00 per hour but, in no case, less than stated in Division-1, whichever is greater.

E. Maintenance and Operating Manuals
   1. The CONTRACTOR shall furnish three (3) copies of type-written maintenance and operating manuals for all electrical equipment, fire alarm equipment, sound system equipment, etc., to the District.
   2. Instruct the District'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 two (2) 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 District's discretion, not less than one (1) or more than fifteen (15) students shall attend each instruction session. Submit fifteen (15) written outline copies of the proposed instruction class curriculum, 14-days prior to the class-scheduled dates.
   3. Maintenance and operating manuals shall be bound in three-ring, hard-cover, plastic binders with table of contents. Manuals shall be delivered to the District's Representative, with an itemized receipt.

F. 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 District's Representative with an itemized receipt.

G. Record Drawings (ADDITIONAL REQUIREMENTS)
   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. At the end of the project, transfer all changes to one set of transparencies to be delivered unfolded to the District's Representative.
   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 District and replace all damaged or defective work, materials, and equipment before requesting final acceptance.

1.11 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 District's Representative.
   3. Prior to penetrating, coring, drilling or cutting existing building elements, concrete and/or masonry, provide imaging equipment examinations of each specific location. The imaging process shall identify existing internal embedded components and locations, including structural elements/anchors, conduit, and piping that are present. Do not penetrate or damage the existing internal embedded elements. Imaging shall employ one (1) of the following, with GPR methodology preferred:
      a. Non-invasive imaging employing high frequency, ground penetrating radar (GPR), single side echo reflection technology.
      b. Non-invasive imaging employing x-ray radiography, through-and-through imaging technology.

B. Excavation Temporary Cover
   1. Excavations for contract work occurring in streets, vehicular drive areas, parking lots, sidewalks; any paved surface; or any area accessible to the public; 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 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.
   3. Provide a minimum of two (2) 100% open lane(s) (12-foot lane width) for vehicular traffic at all times during construction, for vehicle access to all areas.

1.12 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. Provide nameplate label on electrical service entrance equipment describing available short circuit information calculated by the CONTRACTOR, including:
      a. Calculation date, month-day-year.
      b. Calculate maximum available short circuit fault current.
      c. Description of parameters and changes affecting the requirements for recalculation of the fault current information.
   3. 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.
   4. 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.

5. Provide black-on-white laminated plastic nameplates engraved in minimum ¼-inch high letters to correspond with the designations on the drawings. Provide other or additional information on nameplates where indicated.

B. Plates: All cover and device plates shall be furnished with engraved or etched designations under any one of the following conditions (minimum character size not less than 0.188 inch. Engraving shall indicate circuits and equipment controlled or connected):
   1. More than two (2) devices under a common coverplate.
   2. Lock switches.
   3. Pilot switches.
   4. Switches in locations from which the equipment or circuits controlled cannot be readily seen.
   5. Manual motor starting switches.
   6. Where so indicated on the drawings.
   7. As required on all control circuit switches, such as heater controls, motor controls, etc.
   8. Receptacles other than standard 15 ampere 120 volt duplex receptacles; shall indicate circuit voltage, ampere, phase and source circuit number.
   9. Where outlets or switches are connected to emergency power circuit; provide panelboard and circuit number engraved on plate.
   10. Low voltage and signal system outlets.

C. For equipment and access doors or gates to equipment containing or operating on circuits of more than 100 volts AC or DC nominal. Provide red-on-white laminated warning signs engraved in ½-inch high letters to read: "DANGER - 480 *(or applicable voltage)* VOLTS KEEP OUT AUTHORIZED PERSONNEL ONLY".

D. 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 #6AWG or 0.25-inch diameter, shall be provided with polypropylene identification tag holders, with yellow polypropylene tags interchangeable black alphanumeric characters, character height 0.25 inch. Attach identification tags with plastic “tie” wraps, minimum of two (2) for each tag. As manufactured by Almetek Industries-“EZTAG” series; or TECH Products - “EVERLAST” series.
      b. Individual wire and cable #6AWG 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. Junction and pull boxes shall have covers stenciled with box number when shown on the drawings, or circuit numbers according to panel schedule. Data shall be lettered in a conspicuous manner with a color contrasting to finish.

1.13 TESTING

A. The CONTRACTOR shall obtain an independent testing laboratory, provide all instrumentation and perform tests on the electrical system and equipment as hereinafter described and further directed by the District'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 District's Representative for review.
   1. All equipment and personnel required for set-up and testing shall be provided by the CONTRACTOR.

B. Test for Phase to Ground and Neutral Condition:
   1. Open main service disconnects.
   2. Isolate the system neutral from ground by removing the neutral disconnects link located in the service switchboard.
   3. Close all submain disconnects.
   4. Close all branch feeder circuit breakers.
   5. Turn all switches to "on" position, unplug all portable equipment from outlet receptacles.
   6. 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.
   7. Record all readings after 1-minute duration and document into a complete report.
   8. 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.

C. 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" three (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 (2) 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.

D. The testing, calibrating and setting of all ground and ground fault equipment, circuit breakers, circuit 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 District's Representative.

E. Ampere and Voltage Measurements
   1. Measure 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 District'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%.
5. Branch circuit devices 40 ampere or less and motor loads ten (10) horsepower or smaller are excluded from ampere and voltage testing requirement.
6. If, in the opinion of the District'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 District'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 District'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 and conductor/wire connections shall be tightened per manufacturer's instructions and witnessed by the District's Representative.
3. All ground connections shall be completed and identified. Perform and successfully complete all required megger and ground resistance tests.
4. 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 over spray removed and equipment vacuumed clean. The District's Representative shall observe all interiors before covers are installed.
6. All wall, ceiling, and floor work and painting shall be completed within areas containing electrical equipment prior to installation of equipment. The equipment indoor rooms and spaces shall be weather-tight and weather protected from environmental incursions.
7. All doors to electrical equipment rooms shall be provided with locks in order to restrict access to energized equipment.
8. Electrical spaces and rooms shall not be used as storage rooms after power is energized.
9. Outdoor electrical equipment enclosures and housings shall be weather protected.
10. The electrical system time current coordination and ARC-Fault study shall be complete for circuit breakers, ground relays sets, and circuit relay sets, fuses; set-up, tested and calibrated accordingly.

1.14 COMMISSIONING - Cx

A. General
1. The commissioning shall verify the electrical systems for the term of the contract, by observation; and by calibration; and by testing. The commissioning shall ensure the electrical systems perform interactively and correctly, according to the contract and operational requirements.
2. Commissioning shall provide startup, testing and documented confirmation of the contract constructed systems, materials and work, functions in compliance within the criteria set forth in the Contract Documents to the satisfaction of the District's needs. The commissioning scope shall encompass each system identified as requiring "commissioning" by the Contract Documents, including but not limited to:
   a. Electrical circuits' protection, short circuit, overcurrent, and ground fault devices.
   b. Electrical circuits monitoring and metering.
   c. Light fixtures, lamps and ballasts.
   d. Lighting control devices, equipment and lighting control systems.
   e. Standby and emergency electric power supply equipment and systems.
   f. Fire alarm, equipment, devices and fire alarm systems.
   g. Additional systems described in the contract documents.

3. Commissioning process shall review all of the shop drawing submittals, including:
   a. Controls, operation and maintenance requirements.
   b. Facility performance testing compliance.
   c. Project contract requirements compliance.
   d. Compliance with basis for design and operational descriptions provided in the contract.
4. Commissioning shall be the process of ensuring all the systems described in the Contract Documents comply with the Contract Document design; all systems are installed properly; all systems are functional, tested and capable of being operated and maintained to perform within the contract requirements and design intent.
5. Functional setup, recalibration, correcting deficiencies, retesting and the associated costs, for system(s) that fail commissioning, shall be the responsibility of the CONTRACTOR. The CONTRACTOR shall include all commissioning costs in the contract scope of work.
6. Complete all commissioning functions prior to the occupancy of the facility by the District, unless directed otherwise by the District's Representative.
7. Submit three (3) copies of commissioning documentation to District's Representative.
8. Commissioning, unless specifically indicated otherwise, shall be performed by factory-trained technician(s) authorized and certified by the Manufacturers of the respective equipment/systems. Where specifically indicated, commissioning shall be performed by Independent Test Lab.

B. Commissioning Procedures
1. Prepare a commissioning matrix identifying components and systems included in the commissioning scope; the status; actions completed and actions to be completed.
2. Verify CONTRACTOR compliance with Contract Document requirements manufacturer's recommendations and approved shop drawings.
3. Perform startup, functional tests, reports, and document results.
4. Evaluate and document the setup parameters, software, operating condition and performance of each system at the time of functional test completion. Document and record each performance parameter and condition, in the commissioning report.
5. Schedule testing and prepare descriptions of testing.
6. Describe measures performed to correct deficiencies.
7. Verify that instructions to District's Representatives, Operations and maintenance manuals comply with Contract Documents.
8. Prepare warranty matrix identifying the start dates, expiration dates, routine preventative maintenance dates and the District's responsibility for performing preventative maintenance and keeping logs for each maintenance function and warranty claims.
9. Confirm completion of all punch list items that have been acceptably accomplished and a list of what has not been acceptably completed.
10. Describe uncorrected deficiencies accepted by the DISTRICT.

C. Commissioning Phasing

The commissioning phases of work shall include the following activities:
1. SDQ - Shop Drawing Qualification shall verify complete and correct shop drawings have been submitted.
2. IQ – The Installation Qualification of contract work shall verify systems are correctly and properly installed.
3. OQ - Verify systems interfaces and software are correctly and properly operational.
4. ITM - Verify the contract Inspection, Testing and procedures for Maintenance are complete.
5. PQ - Performance Qualification complete the functional performance testing to validate each building system.

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 District and performed only after consultation with the District'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 DISTRICT Representative, with approval in writing.

B. Contract work involving outages or disruption of normal function in electrical power systems, telephone/communication systems, fire alarms, shall be performed during the following time periods. The contract work shall be phased to limit outages in the respective systems to the stated periods:
   1. 11:30 p.m. Friday to 11:30 p.m. Sunday of the same weekend. Work shall occur on multiple weekend periods if a single weekend is not sufficient time to complete the work.
   2. The contract work involving outages shall be phased in multiple work time units, to comply with the permitted outage limitations.

C. Work involving system outages to the building fire alarm system shall be performed only after consultation with the DISTRICT and shall be only at such a time and of such duration as approved in writing. Contractor shall provide continuous "Fire-Watch" during fire alarm system outages and comply with AHJ "Fire-Watch" requirements.

D. Provide overtime work; double shift work; night time work; Saturday, Sunday, and holiday work to meet outages schedule.

E. Provide temporary electrical power to meet the requirements of this Article.

F. Any added costs to CONTRACTOR due to necessity of complying with this Article shall be included in the Contract Scope of Work.

G. When electrical work involving power disruptions to existing areas is initiated, the work shall proceed on a continuous basis without stopping until electric power is restored to the affected areas.

H. The CONTRACTOR shall request in writing to the DISTRICT'S Representative a minimum of 3-weeks in advance, for any proposed electrical outage.

1.16 TEMPORARY ELECTRICAL POWER

A. Provide temporary electrical power if work requiring power outages cannot be completed in time permitted and approved by the DISTRICT'S Representative.

B. Temporary electrical power shall be a standby diesel engine generators. Voltage, frequency, regulation, etc. shall be equal to that of normal utility source. Exhaust system shall have a critical silencing muffler. Generator voltage shall match the existing secondary voltage required at the site. The CONTRACTOR shall furnish all necessary cables, switches, etc., to make all required

   Connections to existing panels, feeders, etc. Generator shall be sized to adequately carry the demand load. If record of demand load is not available, size generator to match corresponding transformer, maximum capacity circuit as directed by the District's Representative.

C. After completion of required usage of the temporary generators, prior to completion of the project, the CONTRACTOR shall remove the generators. All temporary cables, switches, etc. shall be removed and all permanent equipment left in satisfactory condition.

D. Each generator shall be housed in security type sound attenuated housing to prevent access by unauthorized personnel. Temporary power cables, connections, etc. shall be protected from unauthorized personnel.

E. The CONTRACTOR shall be responsible for complete operation of the generator including personnel, fuel supplies, proper safety precautions, etc. Generator shall not be left unattended while in operation.

F. The CONTRACTOR shall provide temporary construction lighting and power as required in areas where work is being performed. Temporary power arrangements, outages, installation, work schedules, etc., shall be submitted in writing 3-weeks prior to requested outage date, and approved by the DISTRICT'S Representative prior to start of work.

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

A. It is understood and agreed that this contract does not contemplate the handling of asbestos, PCB or any hazardous waste material. If asbestos, PCB or any hazardous waste material is encountered, notify the District's Representative immediately. Do not disturb, handle or attempt to remove.

B. Lighting Fixture Demolition Hazardous Materials
   1. The removal of existing lighting fixtures will generate hazardous material waste disposal contract documents.
      a. The existing lighting fixture ballast contains PCB material.
      b. The existing lighting fixture lamps contain mercury.
      c. The existing lighting fixture internal wire insulation may contain asbestos.
   2. Remove, handle, store, contain, dispose of and document the hazardous materials resulting from existing lighting fixtures work, as part of the contract requirements.

1.18 TIME/CURRENT COORDINATION, SHORT CIRCUIT, ARC-FLASH AND SERIES RATED EQUIPMENT

A. Series rated equipment.
   1. 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 and CSA5) by the manufacturer with all equipment and circuit protective devices installed down stream of the identified series rated or current limiting device.
   2. Provide nameplates on all equipment located down stream, including the CLCB and CLF devices, to comply with CEC/NEC paragraphs 110-22 and 240-83 "CAUTION SERIES RATED SYSTEM - NEW DEVICE INSTALLATIONS AND REPLACEMENTS SHALL BE THE SAME MANUFACTURER AND MODELS".

B. Short circuit, coordination and ARC-Flash
   1. Perform engineering analysis and submit engineered settings for each equipment location, fuse and circuit breaker device, showing the correct time and current settings to provide the selective coordination within the limits of the specified equipment. Shall comply with the latest application standards of IEEE and ANSI. Provide electrical system short circuit worst case bolted-fault analysis, both 3-phase line-to-line and 1-phase line-to-ground calculations as part of the coordination analysis recommendations. Provide Electric ARC-FLASH calculations as part of the coordination analysis recommendations.
   2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an engineering narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six (6) copies.

3. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified contract equipment. Shall comply with, but not limited to:

    a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
    b. IEEE-399, Recommended Practices for Industrial and Commercial Power System Analysis.
    c. IEEE-1584, Guide to Performing ARC-FLASH Hazard Study.
    d. CEC/NEC
4. Provide permanent warning labels on each equipment location. The labels shall describe ARC-FLASH, Short-Circuit and Time/Current Coordination, including safety precautions and protective clothing. Also described actions to be taken if any circuit changes or equipment modifications occur.
5. Shall be submitted with the shop drawing submittals for the respective equipment.

1.19 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.

1.20 SPARE FUSES

Provide three (3) spare fuses [for each size and type] [at each location] 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.

1.21 EQUIPMENT SEISMIC AND WIND LOAD REQUIREMENTS (ADDITIONAL REQUIREMENTS)

A. Seismic Performance and Seismic Restraint Requirements
    1. Shall be based on the following:
        a. Soils Site Class: ***
        b. Design Spectral Response Acceleration: ***
        c. Seismic Design Category: ***
        d. Building Component Importance Factor: ***
        e. Building Occupancy Category:***
        f. Mapped Spectral Accelerations: ***
        g. Damped Design Spectral Response Accelerations:***]
    2. Refer to Structural, Architectural, and Soils report contract documents for additional requirements.

B. General
    1. 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 (CBC), International Building Code (IBC).
    2. Provide equipment anchorage details, coordinated with the equipment mounting provision, prepared, signed and "stamped" with PE registration in good standing, by a Civil or Structural Engineer licensed as a Professional Engineer (PE) in the State of California.
    3. 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.
    4. The equipment manufacturer shall document the details necessary for proper wind-load and seismic mounting, anchorage, and bracing of the equipment for floor, ceiling, and wall/ back installation location.

5. Seismic performance shall be based on actual install location of the respective equipment in the building and height above or below grade.
6. The seismic requirements are typical for each equipment item exceeding 19-pounds, including but not limited to the following:
   a. Switchgear, switchboards, and motor control equipment
   b. Transformers
   c. Equipment racks and terminal cabinets
   d. Panels
   e. Conduits with floor, ceiling or wall attachment support and conduits with suspension attachments.
   f. Busway, wire way and cable tray
   g. Uninterruptable power supplies (UPS)
   h. Inverters
   i. Generators and related equipment
   j. Lighting equipment
   k. Fire alarm equipment

C. Certification
   1. Electrical equipment manufacturers and Contractor shall provide Special Seismic Certification (SCC) for each specific equipment configuration with shake-table verification, all furnished as part of the contract documents requirements. The SCC shall include the specific installation location characteristics of the respective equipment including as follows:
      a. Ground or floor attachment
      b. Wall attachment
      c. Ceiling attachment
      d. Roof attachment
   2. Wind Loading
      Electrical equipment and anchorages shall withstand the wind-load imposed at the install location. Wind loading withstand requirements shall apply to all electrical equipment installed in outdoor locations and to all electrical equipment exposed to the weather. The equipment shall be tested and certified by the manufacturer and Contractor. The wind-load withstand qualification of the equipment and anchorages shall be verified by the following methods:
      a. Areo-dynamic wind tunnel test method.
      b. Analytical calculation method, for oversized equipment too large for wind tunnel test method.
   3. The wind-load withstand rating and the SCC shall comply with the requirements of the Authority Having Jurisdiction (AHJ), and include the latest revisions, but not limited to the following:
      a. American Society of Civil Engineers; ASCE-7
      b. CBC/IBC; including but not limited to Sections 1702, 1708, 1709, 1708A and 1709A.
      c. California Office of Statewide Health Planning and Development OSHPD; OPA-Preapproval of Anchorage; Code Application Notice CAN 2-1708A.5 and OSP-Special Seismic Certification Approval
      d. US Department of Homeland Security; FEMA- (installing seismic restraints for electrical equipment)

D. 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 “pre-locate” and lock into the channel “turned lips” and channel walls.

2. Flush mount equipment
   a. Provide anchor attachment of equipment into adjacent wall structural elements.

E. Housekeeping Pad
1. Provide cast-in-place, steel re-enforced concrete raised “housekeeping” pads under all floor standing electrical equipment (except data network equipment racks).
2. Pad sizes
   a. The raised housekeeping pad height shall extend 4-inches above the surrounding finished floor elevation for interior building locations.
   b. The pad shall extend 8-inches below finish grade plus 4-inches above finish grade for outdoor equipment location on grade.
   c. The pads shall extend 7-inches past the “footprint” edge of the respective floor standing equipment.
3. Anchor equipment to pads. Anchor pads to the building structural floor. Equipment pad, equipment re-enforcing and equipment anchoring shall comply with seismic earthquake requirements and wind load requirements.
4. Unless shown otherwise on drawings. The equipment housekeeping pad steel re-enforcing shall consist of two (2) layers of number 4-size steel-rebar laid horizontally and uniformly spaced 6-inches on center. Position rebar in two (2) directions (90-degrees opposed) and centered inside the concrete house keeping pad. Horizontal rebar shall extend to within 3-inches of the edge of the concrete pad in all directions. Metal wire “tie-wrap” shall be provided at each rebar crossing.
5. Equipment anchor attachments shall extend through the housekeeping pad and into the structural concrete below the pad a minimum of not less than 2-inches.

1.22 ELECTRICAL WORK CLOSEOUT

A. Prepare the following items and submit to the District’s Representative before final acceptance.
1. Two (2) copies of all test results as required under this section.
2. Two (2) 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 (2) copies of all receipts transferring portable or detachable parts to the DISTRICT’S Representative when requested.
5. Notify the District’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 District’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.

B. Electrical power single line diagrams – SLD
   1. Provide single line diagrams showing the contract document work complete electrical power system (normal and emergency). SLD shall show inter-connection circuits, electrical equipment, panels, and circuit protection devices, nominal 50% (½-size) approximately 18-inches by 24-inches. Show installed voltages and electrical capacity sizes.
   2. SLD shall be mounted in metal (picture frame) rigid enclosure frame with rigid-backing (backer-board) and clear/transparent front, for hanging on wall. Provide clear transparent cover over SLD inside the frame.
   3. Provide a wall-hung (48-inches) SLD in each “main” and “sub” electrical equipment room. If wall space is limited, alternatively securely attach SLD frame to room door facing into the respective electrical room.

END OF SECTION

SECTION 26 05 15

BASIC ELECTRICAL MATERIALS AND METHODS

PART1 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 (ADDITIONAL REQUIREMENTS}

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. U.L.-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 U.L. "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 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.

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 vyeatherproof gaskets for all exterior boxes.

C. Floor Boxes and Outlets
1. Recessed Combination Power/Signal Floor Box
a. Floor box shall be cast iron, UL listed for concrete installation with leveling screws. Walker "Resource" RFB4-CI Series or equal.
b. Floor box shall be listed for thru wiring.
c. Floor box shall contain four independent, barriered wiring compartments.
d. Overall dimensions shall not exceed 14 1/2" long x 11" 7/8" wide x 3 1/2" deep.
e. Box cover shall be flush with floor and shall provide wire/cable egress points through cover notches. The trim and cover shall be of metal composition. Covers shall be hinged. Walker RAKMTR-BUFF Series or equal.
f. Unit shall include two duplex receptacles as herein specified and two signal system outlets. Walker CIHT-D and CILT-2T.
g. Activation assemblies shall include device mounting brackets, access plates, grommets, partitions, adjusting rings and all associated hardware.

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.

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 – Specification Grade Commercial Series
1. Single Pole Switches

	Toggle Type	Lock Type
Make	20 Amps	20Amps
Hubbell	#CS1221	#CS1221-L

2. Double Pole Switch

Hubbell	#CS1222	#CS1222-L

3. Three-Way Switches

Hubbell	#CS1223	#CS1223

4. Four-Way Switches

Hubbell	#CS1224	#CS1224-L

5. Momentary Contact Switches- 20A at 277V

	3'-Position Req.	3-Position Lock
Hubbell	#1557	#1557-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
Hubbell	#1385	#1386-L	#1385-L	#1226-L

7. Ground Fault Circuit Interrupter (GFCI)
   Hubbell GFST15I, or GFST20I

8. 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 "Centurion" 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 "Nova" 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 "Nova".

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. Hubbell, Specification Grade Commercial Series, Ivory, or equal.

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. Hubbell, Specification Grade Commercial Series, Ivory, or equal.

D. 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. Hubbell, Specification Grade Commercial Series, or equal.

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

2.06 PLATES

Provide plates for every switch, receptacle, telephone, computer, television and other device outlets. All plates shall be 0.040" stainless steel, Type 302 alloy composed of 18% chromium and 8% nickel. Plates shall be manufactured by P & S, Hubbell, Leviton or General Electric only.

2.07 VANDALPROOF FASTENINGS

Provide approved vandalproof type screws, bolts, nuts where exposed to sight throughout the project. Screws for such items as switch plates, receptacle plates, fixtures, communications equipment, fire alarm, blank covers, wall and ceiling plates to be spanner head stainless steel, tamperproof type. Provide OWNER with six (6) screwdrivers for this type.

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 lead 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	IYQg
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 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 capacitive 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 50-0HM 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
a. Nominal line to line	208 Volt	480 Volt
b. Nominal line to neutral	120 Volt	277 Volt
c. Internal capacitance (Microfarads)	2.5	2.5
d. Maximum response time	1-nanosecond	1-nanosecond
e. EMI/RFI noise rejection	25-35DB	25-35DB
f. Nominal peak clamp voltage line to neutral		
and line to ground	205 Volts	330 Volts
g. Minimum transient energy dissipation per phase		
(at 8 x 20 microseconds (waveform))	1000 Joules	1500 Joules
h. Peak transient withstand (at 8 X 20 microseconds waveform)		
without failure of the unit	50000 Amp	60000 Amp
1.Category-C3	80,000Amp	100,000Amp
2.Category-B3	60,000Amp	80,000Amp
3.Category-A3	50,000Amp	60,000Amp

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

2.13 WIREWAY

A. Gener al

Unobstructed lay in type, metal wireway, fittings and connectors U.L. 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, and in compliance with DSA.

B. 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.

C. 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 DIMMER SWITCHES

A. Do not break off dimmer cooling fins.

B. Large dimmers shall be surface wall mounted at the location indicated on the drawings.

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.

3.06 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

SECTION 26 05 30
CONDUIT AND WIRE

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 (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all wire, supports, conduit, fittings and splicing materials.

B. Submit material list for all conduit and conduit fittings.

C. Submit details and structural engineering calculations for conduit support systems.

PART 2 - PRODUCTS

2.01 CONDUIT

A. General
   1. The interior surfaces of conduits and fittings shall be continuous and smooth, with a constant interior diameter. Conduits and conduit fittings shall provide conductor raceways of fully enclosed circular cross section. The interior surfaces of conduits and fittings shall be without ridges, burrs irregularities or obstructions. Conduits and fittings of the same type shall be of the same uniform weight and thickness.
   2. Type of conduit, type of conduit fittings and conduit supports shall be suitable for the conditions of use and the conditions of location of installation, based on the manufacturer's recommendations and based on applicable codes.
   3. All fittings for metal conduit shall be suitable for use as a grounding means, pursuant to the applicable code requirements. All metal conduit and metal conduit fittings shall provide 3 second duration ground fault current carrying ratings, when installed and connected to the respective conduit, as follows:
      a. RMC and EMT conduit fittings.
         1) 0.75 inch through 1.5 inch conduit/fitting size - 10,000 ampere RMS.
         2) 2.0 inch and larger conduit/fitting size - 20,000 ampere RMS.
      b. FMC and LTFMC Conduit Fittings
         1) 0.75 inch through 1.25-inch conduit/fitting size-1,000 ampere RMS (without external bonding jumper).
         2) 1.5 inch through 4.0-inch fitting size-10,000 ampere RMS with bonding jumper.
   4. Protective corrosion resistant finish for metal conduit fabricated from steel and metal conduit fittings fabricated from steel, shall be as follows:
      a. Clean all metal surfaces (including metal threads) with acid bath "pickle" prior to coating, to remove dirt, oil and prepare surfaces for galvanizing.
      b. Hot-dip galvanized zinc coating on all interior and exterior steel surfaces. Minimum finish zinc coating thickness shall not be less than 0.002 inches.
      c. Threads shall be hot-dip zinc coated after machine fabrication.
      d. Exterior metal surfaces shall be finished with clear organic polymer topcoat layer, after galvanizing.

e. The inner metal surfaces of conduit fittings shall be finished with a lubricating topcoat after galvanizing, to facilitate conductor pulling through the conduit/fitting.

5. Threads for metal conduit and metal conduit fittings shall be taper-pipe-thread, National Pipe Standards (NPS) and shall comply with ANSI-B1.20.1.
6. Metal conduit termination connector fittings shall be provided with a manufacturer installed, insulating throat bushing inside the fitting. The bushing shall protect the wire conductor insulation from cutting, nicks and abrasion during conductor installation and electrical load "cycling" after installation is complete. The bushing shall comply with UL 94V-0 flammability.
7. Provide conduit bonding/grounding jumper from metal enclosures with "concentric ring" knockouts, to positively ground/bond each respective conduit(s) to the metal enclosure.
8. Metal conduit fittings connecting to PVC coated metal conduit shall be PVC coated to match the conduit.
9. The conduit and fittings shall be watertight and airtight without cracks and pinholes.

B. Rigid Metal Conduit (RMC)
1. Rigid metal, round tubing, machine threaded at both ends.
   a. The conduit and conduit fittings shall comply with the requirements for an equipment grounding conductor, pursuant to applicable codes.
2. RMC raceway types shall be as follows:
   a. Rigid galvanized steel conduit (RGS), minimum yield strength shall be 35,000 PSI. Shall comply with NEMA standard 5-19 (latest revision); ANSI C80.1 and ANSI-C80.4 (latest revision); UL 514-B and UL 6 (latest revisions); National Pipe Standard Specification (latest revision).
   b. Intermediate steel conduit (IMC). Shall comply with NEMA Standard 5-19 (latest revision) ANSI-C80.6 (latest revision); UL 2142 (latest revision).
3. RMC fittings:
   a. Fittings shall be compatible with RGS and IMC.
   b. Fittings shall be rated "liquid tight".
   c. Fittings imbedded in concrete shall be rated "liquid tight" and "concrete tight".
   d. Connectors and couplings for terminating, connecting and coupling to RMC conduit shall be threaded metal.
   e. Fittings shall comply with ANSI C80.4 and ANSI C33-84 (latest revision); NEMA FB1 (latest revision); UL 514 (latest revision).
   f. Conduit seal fittings:
      1) Conduit seals shall prevent the passage of gasses, liquids and vapors past the location of the seal installation in the conduit.
      2) Conduit seals shall be suitable for installation in both vertical and horizontal conduit locations.
      3) Conduit seals shall be visible and accessible for inspection after installation is complete.
      4) Conduit seals shall be rated for the following locations:
         a) Wet locations
         b) Classified hazardous location materials NEC Class 1 Division 1.
         c) Temperature ranges from 0 [minus 20] degrees centigrade through 90 degrees centigrade.
      5) Conduit seals, sealing compound and sealing compound dam shall be the products of the same manufacturer.
4. RMC fittings as manufactured by:
   a. For threaded enclosure, termination connection.
      1) Thomas & Betts - 106 Series bonding locknut, 5302 series sealing ring with stainless steel retainer.
   b. For non-threaded enclosure, termination connector.

1) Thomas & Betts - 370 Series watertight threaded sealing hub, 106 series threaded bonding lock nut, Sta-Con Series enclosure bonding jumper and 3870 Series threaded ground bushing.
2) Emerson-OZ/Gedney-CHMT/CHT watertight threaded hub with bonding locknut and GH50G Series enclosure bonding jumper.

c. For RMC to RMC conduit-to-conduit coupling
1) Thomas & Betts/Erickson - 674 (threaded) Series
2) Emerson-OZ/Gedney Type TPC (threaded) Series
3) Threaded RMC conduit couplings, product of the same manufacturer as the RMC conduit.

d. For RMC Conduit Seals
1) Emerson-OZ/Gedney-EYA and EYAM (threaded) Series
2) Appleton-EYF and EYM (threaded) Series

C. Electrical Metallic Tubing (EMT)

1. Rigid metal round tubing, “thin wall” steel construction, with non-threaded ends.
a. The conduit and conduit fittings shall comply with the requirements for an equipment grounding conductor pursuant to applicable codes.
b. The conduit shall be watertight and airtight without cracks and pinholes.

2. EMT shall be allowed for conduit size ranges from 0.75-inch through 2.0-inch. EMT is not allowedfor exterior locations, including under covered walks, shelters, or roof overhangs. EMT is not allowed less than ten (10) feet above FF, not in concrete, not underground, and not in runs longer than 100’.

3. Comply with ANSI C80.3, C80.4, and ANSI C33.98 (latest revisions); UL 594 and UL 797 (latest revisions); CEC Section 12500 (latest revision).

4. EMT fittings:
a. Connectors and couplings for terminating, connecting and coupling to EMT conduit shall be non-threaded steel fabrication.
b. EMT termination connector fittings shall be as follows:
1) Set screw type “concrete tight” when installed in dry interior locations.
2) Compression types “raintight” and “concrete tight” when installed in wet or damp locations, outdoors and in concrete or masonry construction.
c. Fittings shall comply with ANSI C33.84 (latest revision); UL 514 (latest revision); NEMA FB-1.

5. EMT fittings as manufactured by:
a. For threaded and non threaded enclosure, termination connector
1) Thomas & Betts-TC721A (set screw type) Series (with locknuts).
2) Emerson-OZ/Gedney-TC500I (set screw type) Series (with locknuts).
3) Thomas & Betts-5123 (compression type) Series (with 2 locknuts).
4) Emerson-OZ/Gedney-TC600I (compression type) Series (with locknut).
5) Thomas & Betts-4240 (compression type) Series (90 degree angle with locknut).
6) Emerson-OZ/Gedney-TWL (compression type) Series (90 degree angle with locknut).
b. For EMT to EMT conduit-to-conduit coupling:
1) Thomas & Betts-TK121A (set screw type) Series (with locknut).
2) Emerson-OZ/Gedney-5000 (set screw type) Series (with locknut).
3) Thomas & Betts-5120 (compression type) Series.
4) Emerson-OZ/Gedney-TC600 (compression type) Series.
c. For EMT to RMC conduit to conduit combination coupling:
1) Thomas & Betts-HT221 (set screw type) Series.
2) Emerson-OZ/Gedney-ESR (set screw type) Series.
3) Thomas & Betts-530 (compression type) Series.
4) Emerson-OZ/Gedney-ETR (compression type) Series.

D. Flexible Metal Conduit (FMC)

1. Round flexible conduit, fabricated from a single continuous steel strip. The steel shall be factory formed into continuous interlocking convolutions to form a complete lock between

steel strips and provide raceway flexibility.

2. Metal to metal grounding contact shall be maintained throughout the length of the FMC conduit.
3. FMC shall be used only for making motor connections, conduit drop from remote junction boxes to fixtures installed above the suspended ceiling, and as specifically noted on the drawings. FMC shall not be used for runs longer than 8 feet; at any exposed locations; for any conduit size larger than 1-1/4".
4. FMC shall comply with ANSI-C.33.84 and ANSI C33.92; NEMA FB-1; CEC 12-1100.
5. FMC Fittings
   a. FMC fittings shall be malleable iron construction or steel construction.
   b. Fitting shall automatically cause the FMC raceway throat opening to be centered with respect to the fitting throat opening.
   c. Straight and angled connector termination fittings shall be threaded on one end and shall include a threaded locknut, suitable for connection to threaded and unthreaded enclosures.
   d. The attachment of the fittings to FMC shall be angled saddle type, to engage and interlock with the FMC spiral groove, and shall be unaffected by vibration. Direct bearing screw type fittings shall not be used.
   e. Direct FMC conduit-to-FMC conduit coupling of FMC shall not be permitted.
   f. Shall comply with ANSI C33.9, and ANSI C33.92 (latest revision); NEMA FB1 (latest revision); U.L. 514.
6. FMC fittings as manufactured by:
   a. Straight Termination Connectors — 45 & 90 Degree Angle Connectors
      1) Thomas & Betts-3110 Series (with locknut) — Thomas & Betts-3130 Series (with locknut)
   b. FMC to EMT conduit combination coupling:
      1) Thomas & Betts 503TB Series.

E. Liquid Tight Flexible Metal Conduit (LTFMC)
1. The metal conduit core of LTFMC shall comply with the same requirements as FMC conduit, with the addition of a thermoplastic exterior flexible jacket over the metal core.
2. The exterior jacket shall be positively locked to the metal core to prevent jacket "sleeving".
3. The LTFMC shall be rated for installation and operating service temperatures of between minus 20 degrees centigrade through plus 90 degrees centigrade.
4. The LTFMC jacket shall be suitable for continuous exposure to sunlight, rainwater, water vapor, mineral oils and liquid solvents, without penetrating into the conduit and without deteriorating the jacket.
5. LTFMC sizes from 0.75-inch through 1.25-inches shall include an additional internal ground conductor, fabricated by the manufacturer, as an integral part of the conduit core.
6. Direct LTFMC conduit-to-LTFMC conduit coupling of LTFMC shall not be permitted.
7. LTFMC shall be allowed for conduit size ranges from 0.75-inch through 4.0-inches.
8. In addition to the requirements for FMC conduit, LTFMC shall also comply with ANSI C-33.84 (latest revision); NEMA-FB1 (latest revision); CEC 12-1400 (latest revision).
9. LTFMC fittings
   a. Fittings shall include an external mechanical ground/bond wire connector.
   b. The attachment of the fitting to LTFMC shall be threaded compression type onto the conduit core with locknut and liquid tight jacket compression seal. The fitting shall automatically prevent "sleeving" of the jacket.
   c. Straight and angled termination connector fittings shall be threaded on one end and shall include locknut suitable for connection to threaded and unthreaded enclosures.
10. LTFMC fittings as manufactured by:
    a. Termination connector fittings:

Straight	45 and 90 Degree Angle Connectors
1) Thomas & Betts-5331 GR Series.	Thomas & Betts-5341GR and 5351GR Series.
2) Appleton-STB Series; STN-L Series for use with preformed"knockouts".	Appleton-STB-L Series; STN-L Series for use with preformed "knockouts".

3) Emerson- OZ/Gedney-4QSeries. Emerson-OZ/Gedney-4Q Series

b. LTFMC to RMC conduit to conduit combination coupling fittings:
   1) Thomas & Betts-5271 GR Series.
   2) Emerson-OZ/Gedney-4Q Series

F. Rigid Non Metallic Conduit (RNMC)
   1. General
      a. Conduit and fittings shall be 90 degree centigrade conductor rated. Fabricated from homogeneous material, free from visible cracks, holes or foreign inclusions, with integral "end-bell". The conduit and conduit fittings shall be watertight and airtight.
      b. Conduit, conduit fittings and conduit fitting assembly "solvent cement" shall all be the product of the same manufacturer. Conduit fittings shall be solvent cement welded watertight.
      c. Conduit and fittings shall be identified with legible markings showing ratings, size and manufacturers name.
      d. RNMC and fitting shall be corrosion resistant, watertight.
      e. Conduit shall be suitable for conductor operating temperatures from minus 20 degrees centigrade to 90 degrees centigrade.
      f. RNMC shall comply with NEMA TC-2 (PVC 40 conduit, latest revision) NEMA TC-6 (EB conduit latest revision) and NEMA TC-3 (fittings, latest revision); UL 514 and UL 651 (latest revision).
   2. Polyvinyl Chloride (PVC)-RNMC
      a. PVC-schedule 40 heavy wall construction.
      b. PVC-schedule 80 extra heavy wall construction.
      c. PVC-type EB.
   3. RNMC fittings connecting to metallic raceways shall be provided with a ground/bond jumper connection.

G. Combi-Duct
   1. Rigid nonmetallic conduit combining an continuous linear outer raceway (duct) with factory installed (inside the outer duct) multiple, segregated inner raceway (ducts). Rigid, schedule 40 PVC construction. Shall be modular lengths of 20-feet for each duct segment.
   2. The conduit shall be suitable for use with signal/ telecommunications, fiber optic, telephone and computer/data circuits, operating at 100 volts or less, UL listed and labeled.
   3. Outer Duct, outer enclosing Schedule-40 PVC duct size. The outer enclosing duct shall be 4.2-inches inside nominal duct diameter and 4.5-inches outer duct nominal diameter.
   4. Inner-ducts (Contained inside the enclosing outer duct), non-metallic SDR-19 or Type-C/CAO-8546:
      Triple Combi-Duct
      a. Quantity of three (3) continuous round rigid inner linear ducts, nominal size inside diameter 1.5-inches for each inner duct.
      Quad Combi-Duct
      b. Quantity of four (4) continuous round rigid inner linear ducts, nominal size inside diameter 1.19-inches for each inner duct.
   5. Manufacturer's standard bends and offsets, minimum 72-inches radius.
   6. Combi-duct and combi-duct fittings shall be airtight and watertight. Approved for direct burial in earth and approved for encasement in concrete.
   7. As manufactured by Carlon # Multi-Guard/Multi-Cell Series; American Pipe and Plastic (AMTEL) #Multi-Bore series; or equal.

H. Expansion Joint, Deflection Joint and Seismic Joint Conduit Fittings
   1. Expansion Conduit Fitting - Fitting shall provide for a minimum of 2-inches straight line movement between two connecting conduits in each direction (total 4-inches conduit expansion and contraction) parallel to the respective conduit lengths. Fitting shall be watertight.

2. Deflection Conduit Fitting - Fitting shall provide for a minimum of 30 degrees angular deflection movement ("Shear" deflection) between two connecting conduits, in any direction perpendicular to the length of the respective conduits. Fitting shall be watertight.
3. Combination Expansion/Deflection Conduit Fitting - Fitting shall provide the combined "expansion" and "deflection" movement capacity between two connecting conduits as described for separate "expansion" and "Deflection" conduit fittings. Fitting shall be approved for installation concealed in both masonry/ concrete construction and exposed non-masonry/concrete construction. Fitting shall be watertight.
4. Fittings shall comply with UL.
5. Fittings as manufactured by:
   a. Conduit expansion fittings exposed or concealed locations as manufactured by:
      1) Emerson-OZ/Gedney – AXB-8 Series for RMC conduit.
      2) Emerson-OZ/Gedney - TX Series for EMT conduit.
      3) Appleton – AXB or XJ8 Series for RMC conduit and EMT conduits. Provide RMC to EMT combination conduit coupling fittings for each end of the expansion fitting.
   b. Combination expansion/deflection conduit fittings exposed or concealed conduit locations as manufactured by:
      1) Emerson-OZ/Gedney - AXDX Series for RMC conduit.
      2) Emerson-OZ/Gedney - AXDX Series for EMT conduit.
      3) Appleton-DX Series for RMC conduit.
      4) Provide RMC to EMT combination conduit coupling fittings for each end of the expansion/deflection fitting.
   c. Conduit expansion/deflection fittings for FMC and LTFMC conduit.
      1) Provide a minimum of 12-inches of "slack" LTFMC in each FMC or LTFMC conduit at building and structure seismic or expansion joint conduit crossings.
      2) Note: Each FMC "slack" expansion/deflection location, shall be considered as not less than a 90 degree conduit bend location, for compliance with the maximum quantity of conduit bends allowed in a raceway.
6. Conduit fitting bonding jumper:
   a. The grounding/bonding path of metal conduit shall be maintained by the fitting.
   b. Provide a bonding jumper at each expansion, deflection and combination expansion deflection conduit fitting.
   c. The jumper shall be a bare flexible copper "braid". The copper braid electrical current carrying capacity shall be equal to the metal conduit.
   d. Provide a factory terminated ground clamp on each end of the braid with adjusting steel conduit grounding clamps and connect to each respective conduit end.
   e. The jumper braid length shall be 8-inches longer than the respective conduit fitting.
   f. Bonding jumper for FMC and EMT fittings as manufactured by:
      1) Emerson-OZ/Gedney – BJ and BJE Series
      2) Appleton – BJ/XJ Series

I. Conduit Bodies Conduit Fitting
1. Conduit bodies shall provide conductor access with a removable conduit body cover and wiring area enclosed in metal housing. The conduit body shall facilitate pulling conductors.
2. In-line form "C" conduit bodies shall be prohibited.
3. The interior space "length" of 90 degree "elbow" conduit bodies shall not be less than six (6) times the diameter size of the largest conduit connecting to the conduit body.
4. Conduit body covers shall be removable, gasketed; watertight "domed" metal covers "Mogul-Type" with threaded screw attachment to the conduit body.
5. Lubricated, reusable, wire roller guards inside the conduit body shall protect wire from insulation damage during wire "pulling".
6. Conduit body fittings shall comply with UL 514.
7. Conduit bodies as manufactured by:
   a. For RMC Conduit
      1) Hubbell/Killark – LB/Mogul (90-degree elbow) Series – threaded body.

2) Emerson-OZ/Gedney - LB 6X/Mogul (90 degree elbow) Series - threaded body.
3) Appleton – NEC6X-LB/Mogul (90 degree elbow) Series - threaded body.

b. For EMT Conduit
1) Same as for RMC conduit. Provide EMT to RMC conduit combination coupling fitting for each outlet body connection.

2.02 PVC COATING

A. PVC coatings shall be provided as described for specified metal products.

B. PVC coating shall be factory applied, to comply with NEMA-RN1 and 5-19.

C. The adhesion of the PVC coating to the coated metal shall exceed the strength of the coating itself, based on 0.5-inch “strip-pull” test.

D. Uniform coating thickness shall be continuous without “breaks” or “pinholes” and shall not be less than the following:
1. Exterior metal surfaces, 40-millimeter coating thickness.
2. Interior metal surfaces, 10-millimeter PVC or urethane coating thickness (i.e. interior of conduits, interior of conduit fittings etc.).

2.03 CONDUIT SUPPORTS

A. General
1. Conduit Supports, hangers and fasteners for metal conduit shall be steel, hot dip zinc galvanized.
2. Conduit supports, hangers and fasteners for PVC coated conduit shall be PVC coated to match the conduit PVC coating.
3. Threaded hardware shall be continuous, free running threads.
4. Conduit support systems, including support channels, pipe clamps, braces, anchors, hardware, fasteners, shall be sized to support the full capacity circuit conductors weight, plus the installed conduit weight, plus the conduit fitting weight and support hardware weight, plus a 300% additional weight capacity safety factor.
5. Provide lock washer at each “bolted”/threaded connection.
6. Conduit supports, fasteners, channels, braces, hardware, anchors, pipe clamps, and hangers as manufactured by Unistrut or Kindorf.
7. Supports shall be free of “BURRS” and sharp edges.
8. Metal supports cut in the field shall be zinc galvanized after cutting to prevent rust.

B. Conduit Hangers
1. Threaded steel hanger rods.
a. Hanger rods smaller than 0.375-inches in diameter shall not be used for support of individual conduits.
b. Hanger rods smaller than 0.5-inches in diameter shall not be used for support of multiple conduits.
2. Conduit hanger wires shall be not less than 12-gauge steel.
3. Conduit hangers shall attach to structure fasteners with steel “Clevis” or “Swing” hangers and shall provide a minimum of 45 degrees of angular movement in any direction at the point of the conduit hanger attachment to the structure fasteners.
4. Conduits individually suspended by conduit hangers shall fasten to the respective hangers with “Clevis” type pipe hangers. The pipe hangers shall be steel, adjustable to fit conduit size and shall completely enclose the conduit circumference.

C. Conduit Support Channels
1. “C” channels shall be factory preformed with a minimum 12 gauge thickness metal. The channel shall be factory “punched” with regularly spaced slotted holes for fastener attachments along the length of the channel.

2. The “C” channel shall not deflect more than 0.1 inches between channel supports at maximum installed design load, including required safety factor.
3. Channels shall comply with ANSI-1008 (latest revision) and ASTM-A569 latest revision).
4. Channels shall provide “turned lips” at longitudinal edges to hold (lock-in) fasteners.
5. Conduit support channels suspended from conduit hangers shall attach to conduit hangers with treaded connections. Provide a minimum of two hangers (trapeze style) connected to each channel.
6. Non-suspended conduit support channels shall connect to structure fasteners with threaded connectors.

D. Fasteners, Seismic Earthquake Rated
1. Channel fasteners:
   a. Channel fasteners shall “prelocate” and lock into the channel ”turned lips” and channel “walls”.
   b. A separate metal strap shall “tie” each conduit to each channel with conduit channel fasteners.
2. Structure fasteners:
   a. Structure fasteners for wall and floor mounted conduit attachments shall attach to existing masonry and concrete structures with structure fasteners using drilled, mechanical, expansion shield anchors.
   b. Structure fasteners for wall and floor mounted conduit attachments shall attach to new masonry and concrete structures with structure fasteners using steel threaded inserts precast into the structures.
   c. Structure fasteners shall center the support load above or below the beam flanges and reduce torsion-rotation forces exerted on the structural beam. Attach to steel structural members with “swing-beam clamps”, with set-locking screw structure fasteners.
      1) Beam clamps shall include integral safety rod, strap or “J”-hook to secure the attachment clamp to the beam flanges on both sides of the beam, with integral hanger rod attachment.
      2) Or double-ended beam clamp to secure the attachment clamp to the beam flanges on both sides of the beam, with integral hanger rod attachment.
   d. Structure fasteners for wall and floor mounted conduit attachments shall attach to wood structural members with flush “through-bolted” wood beam/wood framing stud structure fasteners.
   e. Structure fasteners for wall mounted conduit attachments shall attach to steel framing studs and steel structural elements with spot welded steel structure fasteners or drilled and bolted structure fasteners.

E. Brace Connectors
1. Provide lateral brace connectors to resist horizontal, lateral and vertical movement of suspended conduits during seismic earthquakes.
2. The braces shall connect from each conduit support, attach as close to the conduit as possible, and attach to fixed rigid, nonsuspended building “main” structural elements with fixed anchoring.
3. Brace attachment connectors and fasteners shall be rigid preformed steel channels or flexible #10 gauge steel hanger wire.
4. Connect and attach the brace connectors to fixed structural elements in the same manner as conduit support hangers. The connection of braces to structural elements shall be independent of the conduit support hanger structure fasteners.

2.04 ELECTRICAL POWER WIRE AND CABLE

A. General
1. All wire and cable shall be single-conductor, annealed copper, insulated 600 volt, #12AWG minimum unless specifically noted otherwise on the drawings.

2. Conductors #10AWG and smaller shall be solid. Conductors #8AWG and larger shall be stranded.
3. Insulation of conductor connected to circuit protection devices required to be "100%" rated, shall be 90 degree centigrade rated insulation.
4. Insulation of conductors installed outdoors, on grade or underground, insulation shall be rated for wet locations.
5. Insulation of conductors installed outdoors, installed exposed to the sun, installed in exposed conduits, insulation shall be rated for high-temperature 90 degrees centigrade.
6. Insulation of branch circuit conducts installed in light fixtures, insulation shall be rated for 90 degrees centigrade.
7. Conductor exposed to oil, insulation and jacket shall be oil resistant, complying with “Oil Resistant-1” and “Oil Resistant-2” UL 83.

B. Conductor Insulation
1. 600 Volt AC and/or DC insulated conductors installed entirely inside conduits, or enclosed inside wireways, or enclosed inside raceways, insulation shall be rated as follows.
2. Indoor above Grade locations either concealed or exposed.
   a. Dual rated THHN and THWN
   b. Individually rated THHN-2
   c. Individually rated THWN-2
   d. XHHW-2
3. Outdoor above Grade either concealed or exposed.
   a. XHHW-2
   b. THWN-2
   c. THW-2
4. Outdoor below Grade or outdoor on Grade.
   a. XHHW-2
   b. THWN-2
   c. THW-2
5. All other enclosed raceway locations not described above.
   a. XHHW-2
   b. THWN-2
   c. THW-2
6. Health Care facilities all circuits insulation shall be XHHW-2, rated Hospital-Grade.
7. 600 Volt AC and/or DC insulated conductors installed in open cable tray or open wireway or exposed insulation also shall be rated for exposed install locations.

C. Insulation Color Coding and Identification
1. The following color code for branch circuits:
   a. Neutral . . . White (Tape feeder neutrals with white tape near connections)
   b. Normal Power:

120/208 Volt		480/277 Volt	Ground
Green		Ground	Green
Phase A	Black	Phase A	Brown
Phase B	Red	Phase B	Orange
Phase C	Blue	Phase C	Yellow

   c. Isolated ground insulation shall be green with a longitudinal yellow stripe.
   d. Emergency power same insulation color as normal power except as follows:

120/208 Volt	480/277 Volt
Provide a continuous stripe on each conductor insulation, orange or yellow, except ground	Provide a continuous stripe on each conductor insulation blue or black, except ground

2. When individual neutral conductors are shown for each branch circuit, the color code for the neutral conductors shall be as follows:
   a. 120/208 volt; Phase A - White with Black stripe; Phase B - White with Red stripe; Phase C - White with Blue stripe.
   b. 277/480 volt; Phase A - White with Brown stripe; Phase B - White with Orange stripe; Phase C - White with Yellow stripe.
3. Feeders identified as to phase or leg in each, switchboard, switchgear, panelboard and junction location with printed identifying tape.
4. Fire alarm conductors: Use 600-volt, type THHN-2/THWN-2 conductors and color-coded per equipment manufacturer's recommendations and approved and listed for use on fire alarm systems by the State Fire Marshal.
5. Color coding for mechanical and plumbing control wiring shall be an agreed upon color code between the Mechanical/Plumbing CONTRACTOR and the Electrical CONTRACTOR, and color code shall be submitted to the DISTRICT'S REPRESENTATIVE in writing for approval prior to installation.

D. Panel feeders shall be copper:
1. Wire size shown on the drawings is for copper conductors, unless specifically indicated otherwise.
2. If the conductor termination is to be made on a bus bar or similar flat surface, a Burndy Type YA-A HYPLUG compression terminal intended for the specific conductor size, factory filled with oxide inhibitor compound shall be used. Terminal must be installed using a hydraulic compression tool equipment with a die head for the particular terminal used. Only Burndy Hypress tools shall be used for compression.
3. If the conductor termination is to be made into a circuit breaker or similar insert compartment it shall be terminated by use of a Burndy AYP HYPLUG compression connector intended for the specific conductor size, factory filled with oxide inhibitor compound. Connector must be installed using only Burndy Hydraulic compression tool specifically approved for each respective connector.
4. Connector aid shall be used for all terminations and connections. Connector aid shall be Burndy Pentrox A, NO-OX-1D Grade "A".
5. When an aluminum lug is terminated to a copper bus with a steel or copper stud or bolt, place aluminum lug on stud or bolt followed by a flat steel washer, a Belleville washer, and steel or copper nut, in that order.

2.05 CHEMICAL GROUND ROD

A. General
1. Self contained ground rod(s) using chemically enhanced grounding shall be provided where specifically indicated on the drawings. As manufactured by Lyncole XIT Grounding Systems, 22412 South Normandie Avenue, Torrance, CA. Telephone #(800) 962-2610; or Superior Grounding Systems, Irwindale, CA. Telephone #(800) 747-7925; or ERICO – Eritech Chemical Ground Electrode.

2. The ground rod shall operate from changes in atmospheric pressure pumping air through the ground rod, hygroscopically extracting moisture from the air to activate the ground electrolytic chemicals and improve the ground rod performance.
3. Ground rod system shall be UL-467 listed.
4. Ground rod system shall be 100% self-activating, sealed and maintenance free. The addition of chemical or water solutions shall not be required.

B. Ground Rod
1. Ground rod shall consist of a 2-inches nominal diameter hollow, copper tube. The tube shall be permanently capped on the top and bottom. Air breather holes shall be provided in the top of tube. Drainage holes shall be provided in the bottom and sides of the tube for electrolyte drainage into the surrounding soil.

2. The ground rod shall be chemically filled at the factory with environmentally non-hazardous water-soluble metallic salts to enhance electrical grounding performance.
3. Ground rod shall be a minimum of 10-feet long for straight (vertical) installation; or “L” shape minimum 20-feet long for horizontal installation.
4. Ground wire clamping “U-Bolt” with pressure plate on the top end of the tube sized for 1#2 through 500 MCM AWG ground electrode conductor connection, and stranded 4/0AWG copper pigtail exothermically welded to the side of rod for ground electrode conductor connection.

C. Ground Box
1. Precast concrete box with slots for conduit entrances. Approximately 10-inch diameter by 12-inches high. Cast iron grate flush cover with “Breather” slots XIT Box #XB-12.

D. Backfill Material
1. Natural volcanic, non-corrosive Bentonite Clay backfill material.
2. Shall absorb water at a minimum of thirteen times its dry volume or approximately 14 gallons for 50 pounds of clay.
3. PH value 8-10 with maximum resistivity of 2.5 OHMS-M at 300% moisture content by weight.

2.06 FLEXIBLE CORDS AND PORTABLE CABLES

A. General
1. Multi-conductor insulated flexible cable with jacket rated extra heavy duty, extra hard-use and high abuse duty; ozone, sunlight, grease, oil resistant-UL 83 and water resistant; rated for indoor/outdoor use.
2. Quantity of conductors and conductor sizes as indicated on the drawings but in no case less than five 16AWG.
3. Characteristics:
   a. Conductors - stranded copper, soft annealed conforming to ASTM-B-174 and ASTM-B-172. 600 volt individually insulated and color-coded. Separate green insulated ground conductor. Aluminum conductors shall not be permitted for cords and cables.
   b. Insulation - rubber conforming to UL 62; temperature range plus 105 Centigrade to minus 50 Centigrade.
   c. Flame resistance shall conform with MSHA-P123-103.
   d. Jacket - black for equipment connections and yellow for outlet connections. Rated for temperature range plus 105 Centigrade to minus 50 Centigrade, water, sunlight and ozone resistant. Permanently mark jacket a minimum of 40-inches on center with rated voltage, manufacturer's name, wire/insulation type, AWG conductor size and quantity (minimum 24-inches on center).

2.07 CABLE RACKS

A. Cable racks, installed on the vertical walls of the structure, including hooks and porcelain insulator cable cradles, shall be sufficient to accommodate the cables and splices.

B. Vertical racks shall be installed on all walls of the structure a minimum of 24-inches on center within 6-inches of floor and top of wall. A rack shall be installed within 18-inches of each corner of each wall. Additional racks spaced equally on each wall shall be installed; spacing between vertical wall racks shall not exceed 24-inches.
1. Wall racks shall be slotted to accept removable hooks and lock hooks into place.
2. Non-metallic, 50% (minimum) glass reinforced nylon or non-metallic material of the same characteristics.
3. The installed cable racks, cable support hooks with arms and wall anchor bolts shall support the following minimum loads for each hook/arm, with a 200% minimum safety factor. Based on multiple hook/arms located not less than 9-inches on center along the entire vertical length of the support rack:

Hook/Arm Length	Min. Weight Each Hook/ Arm Supported	Max. Allowable Hook/ Arm Deflection
a. 8-inch	450 pounds	0.25-inch
b. 14-inch	350 pounds	0.37-inch
c. 20-inch	250 pounds	0.37-inch

(Based on load concentrated 1-inch from the end of each hook/arm.)

4. Racks shall be bolted to the precast and cast-in place structure walls, within 3-inches of each rack end and not less than 9-inches on center. Provide cast-in place or after-set drilled expansion concrete anchors.

PART 3 - EXECUTION

3.01 TRENCHING, FOOTINGS, SLEEVES

A. Provide trenching, concrete encasement of conduits, backfilling, and compaction for the underground electrical work, in accordance with applicable sections of this specification.

B. Provide footings for all post and/or pole-mounted lighting fixtures: concrete shall conform to the applicable sections of this specification.

C. Sleeves
   1. Provide sleeves for raceways, conduit and wire/cables passing through the following construction elements:
      a. Concrete and masonry foundations, floors, walls and slabs.
      b. Gypsum, Lath, and plaster walls and ceilings.
      c. Building structures (i.e., foundations, walls, floors, ceilings, beams, and roofs) with a fire rating exceeding 20-minutes.
   2. Sleeves shall extend 1.5-inches above and below floors, except under floor standing electrical equipment. Sleeves shall be flush with wall ceiling foundations and partitions exposed to public view and extend approximately 0.5-inches past penetration in fire rated construction. Sleeves shall be installed at exact penetration locations and angles to accommodate wire/cable, raceway and conduit routings.
   3. Joists, girders, beams, columns or reinforcing steel shall not be cut or weakened. Where construction necessitates the routing of conduit or raceways through structural members, framing or footings, written permission to make such installation shall first be obtained from the DISTRICT'S REPRESENTATIVE. Such permission will not be granted, however, if any other method of installation is possible.
   4. The layout and design of raceways and conduits located in or routed through masonry or reinforced beams or the DISTRICT'S REPRESENTATIVE shall review walls before any work is performed. All sleeving shall be accomplished according to the instructions of the DISTRICT'S REPRESENTATIVE and shall be accepted before any concrete is poured.
   5. Sleeves, raceways and conduit shall be located to clear steel reinforcing bars in beams. Reinforcing bars in walls shall be offset to clear piping and sleeves.
   6. Provide a continuous clearance between the inside of a sleeve and exterior of wire/cables, conduits and raceways passing through the sleeve not less than the following:
      a. 0.5-inch clearance except as required otherwise.
      b. 1.0-inch clearance through outside walls below grade.
      c. 3.0-inch clearance through seismic joints.
   7. Sleeves set in fire rated construction shall be caulked between sleeve and building structure, additionally sleeves shall be caulked between the sleeve and the wire/cables, conduits/raceways passing through the sleeve. The caulking shall be a fireproof sealant, equal to the fire rating and temperature being penetrated. Clearance between components inside of sleeve and exterior of components passing through sleeve and between components inside the sleeve shall comply with fireproof sealant manufacturer's recommendations.
   8. Sleeve material:
      a. In floor construction: Schedule 40 black steel pipe, with upper surface to be sealed watertight.
      b. In concrete or masonry walls roofs or ceilings: Schedule 40 black steel pipe. When installed in roofs or outside walls, seal outer surface watertight.
      c. In fire rated construction; 24 gauge galvanized iron or steel.

d. Sleeves through waterproof membranes: Cast iron or Schedule 40 steel with flashing clamp device and corrosion resistant clamping bolts. Caulk space between pipe and sleeve and surfaces between sleeve and conduits sealed watertight.

3.02 GROUNDING

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

B. Where nonmetallic conduit is used in the distribution system, the CONTRACTOR shall install the proper sized copper ground wire in the conduit with the feeder for use as an equipment ground. The electrical metallic raceway system shall be grounded to this ground wire.

C. The maximum ground/bond resistance to the grounding electrode shall not exceed 1 ohms from any location in the electrical system. The maximum ground resistance of the grounding electrode to earth shall not exceed 5 ohms.

D. Ground/Bond Conductors

1. Provide an additional, dedicated, green insulation equipment ground/bond wire inside each conduit type and raceway as follows. Size the ground/bond conductors to comply with CEC/NEC requirements. The metal conduit or raceway shall not be permitted to serve (function) as the only (exclusive) electrical ground return path:
   a. All types of nonmetallic conduit and all types of non-metallic raceways including but not limited to: RNMC - Rigid Nonmetallic Conduit.
   b. FMC - Flexible Metal Conduit.
   c. LTFMC - Liquid Tight Flexible Metal Conduit.
   d. Metal and non-metal raceways.
   e. RMC - Rigid Metal Conduit.
   f. EMT - Electrical Metal Tubing.
2. The equipment ground/bond wire shall be continuous from the electrical circuit source point of origin to the electrical circuit end termination utilization point as follows:
   a. Every conduit and raceway path containing any length of the above identified conduits or raceway.
   b. Every conduit path and raceway path connected to any length of the above-identified conduits and raceways.
3. The equipment ground/bond wire shall be sized as follows, but in no case smaller than indicated on the drawings. Install equipment ground/bond wire in each conduit/raceway, with the respective phase conductors:
   a.

Feeder, Subfeeders & Branch Circuit Protection	Min. Equipment Ground Wire Size
15 Amp	#12
20 Amp	#12
30 to 60Amp	#10
70 to 100 Amp	#8
101 to 200 Amp	#6
201 to 400 Amp	#2
401 to 600 Amp	#1
801 to 1000 Amp	2/0
1001 to 1200 Amp	3/0
1201 to 1600 Amp	4/0
1601 to 2000 Amp	250 MCM
2001 to 2500 Amp	350 MCM
2501 to 4000 Amp	500 MCM

4. Isolated grounds - Raceways containing branch circuit or feeder phase conductors connected to panelboards equipment, or receptacles with isolated grounds or isolated ground bus shall contain a dedicated insulated ground conductor connected to the isolated ground system only. The isolated ground conductor shall be continuous the length of the raceways and connected only to the isolated ground terminals in addition to and independent

of the equipment bonding/ground conductor. The isolated ground conductor shall be sized as indicated above, for equipment ground/bond wire.

5. Splices in ground/bond wires shall be permitted only at the following locations:
   a. Ground buses with listed and approved ground lugs.
   b. Where exothermic welded ground/bond wire splices are provided.
6. Provide ground/bond wire jumpers for conduit fittings with ground lugs, expansion and deflection conduit fittings at conduit fittings connecting between metallic and non-metallic raceways and to bond metal enclosures to conduit fittings with ground lugs.

E. Where conductors are run in parallel in multiple raceways, the grounding conductor shall be run in parallel. Each parallel equipment-grounding conductor shall be sized on the basis of the ampere rating of the overcurrent device protecting the circuit conductors in the raceway. When conductors are adjusted in size to compensate for voltage drop, grounding conductors, where required, shall be adjusted proportionately in size.

F. Ground conductors for branch circuit wiring 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.

G. Each panelboard, switchboard, 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.

H. UFER Ground
1. In addition to all cold water and structural steel grounds provided to meet this specification, there shall be a main ground system of the UFER ground style.
2. The UFER ground electrodes shall be a minimum of two (2) 20-feet lengths of #4/0 AWG bare stranded copper cable embedded horizontally in the cast in place concrete footing, extending in opposite directions in the footings. All portions of the ground electrodes shall be placed inside the concrete, between 2-inches and 4-inches from the earth surrounding the concrete.
3. The lengths of cable shall extend in opposite directions in the footings, with the center end of each cable terminated onto the main electrical service ground bus for the main electrical service equipment.
4. All wire cable connection terminations onto the ground bus shall be exothermic weld type.
5. The “UFER” grounding electrode, embedded in concrete, shall be exothermically welded to each steel reinforcing bar (rebar) and each steel anchor bolt located within 18-inches of the grounding electrode inside the concrete. Note: Reinforcing steel (rebar), in concrete foundations, attached with metal “tie-wraps” and in direct physical contact to other adjacent rebar that is in turn exothermic welded to the UFER grounding electrode, may be classified as attached to the UFER grounding electrode, and does not require additional exothermic weld connections to the UFER grounding electrode.

I. Provide a separate ground/bond insulated grounding electrode conductor, copper wire from the main electrical service ground bus to each of the following locations. The ground/bond conductor shall be sized to comply with applicable codes and as indicated on the drawings, but in no case smaller than the following:
1. Main service entrance equipment ground bus:
   a. Services smaller than 1200 ampere 1.5-inch conduit with 1#4/0.
   b. Services 1200 ampere and larger 2.5-inch conduit with 1#500MCM.
   c. Where a separate ground bus is not required, connect ground to electrical equipment metal housing
2. Each telephone backboard and signal system backboard location, 1.25-inch conduit with 1#1.
3. Metal cold water pipe located inside the building, 1.5-inch conduit with 1#4/0.
4. Outdoor underground metal cold water pipe, make connection five feet from the building, 1.5-inch conduit with 1#4/0.
5. Each transformer (size as indicated and to comply with applicable codes).

6. Each service entrance ground bus and each separately derived ground rod system:
   a. Services smaller than 1200 ampere 1.5-inch conduit with 1#4/0.
   b. Services 1200 ampere and larger 2.5-inch conduit with 1#500MCM.
7. Separate 1.25 inch conduit with 1#2 (AWG) bonding conductor to each interior metal pipe system located in the same building, including but not limited to, the following:
   a. Fire sprinkler system each stand pipe location (water based and non-waterbased).
   b. HVAC chilled water supply and return, at each pump location.
   c. Roof drains.
   d. Waste liquid disposal systems.
   e. Metal gas pipe service entrance and service meters.
   f. Hydraulic elevator hydraulic pipes.

3.03 CONDUIT

A. General
1. The sizes of the conduits for the various circuits shall be as indicated on the drawings, but not less than the conduit size required by code for the size and quantity of conductors to be installed in the conduit.
2. Conduits shall be installed concealed from view. Install conduits concealed in walls, concealed below floors and concealed above ceilings, except as specifically noted otherwise.
   a. Conduits shall not be installed in concrete floors.
3. The following systems shall be considered as circuits 100 volts and less, all other circuits shall be considered to be over 100-volts (power circuits) unless specifically noted otherwise: Fire alarm, energy management control, telephone, public address, data, computer, television, intercom, intrusion alarm and nurse call.
4. Conduits shall be provided complete with conduit bends, conduit fittings, outlet boxes, pullboxes, junction boxes, conduit anchors/supports, grounding/bonding for a complete and operating conductor/wire raceway system.
5. Metal and nonmetal conduits shall be provided mechanically continuous between termination connection points. Metal conduit shall be provided electrically continuous between termination connection points.
6. Individual conduit paths and home runs shown on the drawings shall be maintained as separate individual conduits for each homerun and path.
7. Conduits, conduit fittings and installation work occurring in classified hazardous materials locations shall comply with applicable code Class 1 Division 1 requirements, unless specifically noted otherwise.
8. Transitions between conduits constructed of different materials and occurring in above grade locations shall be allowed only at outlet boxes, junction boxes, pull boxes, and equipment enclosures unless specifically indicated otherwise. Provide outlet boxes and junction boxes.
9. Metal conduit terminating to nonmetal enclosures; terminating into metal enclosures with “concentric.ring” knockouts; terminating into metal enclosures with knockout reducing washers, including but not limited to equipment housings, outlet boxes, junction boxes, pull boxes, cable trenches, manholes, shall be provided with a ground/bonding lug integrated with the conduit termination conductor fitting construction, by the fitting manufacturer. The lug shall provide for connection of a grounding/bonding conductor (insulated or uninsulated). The grounding lug shall be located on the fitting, inside the termination enclosure.
10. The type of conduit, type of conduit fittings, and type of conduit supports and method of conduit installation shall be suitable for the conditions of use and conditions of location of installation based on the manufacturer’s recommendations; based on the applicable codes and based on the requirements of the contract documents.

B. RMC Installation Locations

RGS, IMC conduits and RGS, IMC fittings shall be installed in the following locations:
1. Embedded in floors, walls, ceilings, roofs, foundations, and footings constructed with concrete.
2. Embedded in walls and foundations constructed with brick and masonry.

3. Interior of buildings, within 9-feet of finish floor lines for exposed conduit locations.
4. Exterior of building for exposed conduit locations.
5. Damp or wet locations, exposed or concealed locations.
6. Exposed on roofs.
7. In hazardous materials areas and locations; below hazardous materials areas and locations; above hazardous materials areas and locations.
8. Exposed on utility service poles, for pole risers less than 9-feet above finish grade.
9. RMC conduit and RMC fittings may be installed in any location where EMT and FMC conduit is permitted to be installed.

C. PVC Coated RMC Installation Locations

PVC coated RMC conduit and PVC coated RMC fittings shall be installed in the following locations:

1. Underground conduit locations for elbows and bends with a radius of less than 36-times the conduit diameter.
2. Underground vertical risers extending above grade.
3. Entire length of underground conduits for the following circuits:
   a. Audio microphones
   b. Lighting dimming controls
4. Installed in contact with earth or corrosive materials.
5. Exposed in “cold” rooms and “refrigerated” rooms, rooms with a maintained temperature below 65 degrees Fahrenheit.

D. EMT Installation Locations

EMT conduit and EMT fittings may be installed in the following locations, for circuit conductors operating below 600 volts to ground; locations containing only “non-hazardous materials”; only dry locations:

1. Concealed in hollow non masonry/non-concrete, metal stud frame and wood stud frame walls and floors.
2. Concealed above ceilings.
3. Exposed inside interior enclosed crawl spaces.
4. Exposed interior locations placed 10-feet or higher above finished floors (except as described in paragraph below at lower heights).
5. Exposed on walls and ceilings (any height) in the following dedicated function areas, interior enclosed room locations:
   a. Indoor enclosed electrical equipment rooms and closets.
   b. Indoor enclosed data and telecommunication terminal rooms and closets.
   c. Indoor enclosed HVAC equipment rooms and closets.
6. Any location where FMC is described to be installed, except as the final connection to rotating or vibrating equipment.

E. FMC Installation Locations

FMC conduit and FMC fittings may be installed in the following locations for circuit conductors operating below 600 volts to ground; locations containing only “non-hazardous materials”; only dry, interior locations:

1. Concealed in hollow non-masonry metal stud frame and wood stud frame fully enclosed walls.
2. Concealed above fully enclosed ceiling spaces.
3. FMC conduit shall be installed in continuous lengths between termination points. FMC shall not be “spliced” or coupled directly to FMC or any other conduit type under any circumstance.
4. The maximum continuous length of FMC that shall be installed between termination end points is 8-feet. Circuits requiring continuous conduit lengths exceeding 8-feet between termination end points shall be installed using either RMC or EMT conduits. FMC lengths shorter than 16-inches are prohibited.
5. The minimum size FMC conduit shall be as shown on the drawings but not be less than the following:
   a. FMC lengths of six feet or less, minimum FMC conduit size shall be 0.75-inch.

F. LTFMC Installation Locations

LTFMC conduit and LTFMC fittings shall be installed in the following locations for circuit conductors operating below 600 volts to ground; locations containing only “non-hazardous materials”:

1. Final electrical connection to vibrating or rotating equipment; control and monitoring devices mounted on vibrating and rotating equipment including the following. Minimum conduit length shall not be less than 24-inches:
   a. Motor, engines, boilers, solenoids, and valves.
   b. Fixed mounted “shop” (manufacturing) production equipment.
   c. Fixed mounted food preparation equipment and “kitchen” equipment.
2. All locations where exposed flexible conduit connections are required, both indoor and outdoor.
3. Final connection to indoors electrical transformers. Minimum conduit length shall not be less than 24-inches; maximum conduit length shall not exceed 72-inches.
4. Do not install LTFMC located in environmental air plenums.

G. RNMC Installation Locations

RNMC conduit and RNMC fittings shall be installed in the following locations containing only “non-hazardous material”:

1. Underground, concealed below earth grade, unless specifically noted or specified otherwise.
2. Exposed on utility service poles, for pole risers at 9-feet or higher above finish grade, schedule 80 PVC only.
3. RNMC type “EB” conduit(s) shall be concrete encased along the entire length of the conduits for all installation locations.

4. Non-metal type raceways and RNMC type conduit shall not be installed inside buildings.

H. Combi-Duct Installation Locations

Combi-duct conduits shall be installed where shown on the drawings. Combi-duct shall be installed underground (below grade) as follows:

1. Do not install exposed or inside buildings above grade.
2. Provide a 0.25-inch pull rope in each inner duct.
3. Radius and elbows shall be rigid non-metallic, PVC, manufacturer factory fabricated, in lieu of PVC coated RMC conduit.
4. Inner ducts shall be supported by internal spacers inside the enclosing outer duct.
5. Provide end bell and three (3) hole "snug-plugs" at each entrance end of Combi-duct into pullboxes, manholes, equipment cabinets stubups and Combi-duct terminations. Compression type “snug-plugs” shall provide watertight and airtight seal between inner and outer ducts and around future cables installed in inner duct.

I. Conduit Installation

1. Conduit Supports
   a. Securely and rigidly support all raceways/conduits from the building structure. Raceways/Conduits shall be supported independent of all piping, air ducts, equipment ceiling hanger wires, and suspended ceiling grid systems. Secure conduit to structural element by means of UL listed and approved hangers, fasteners, “C” channels and pipe clamps.
   b. Provide conduit supports spaced along the length of the conduit as follows:
      1) RMC and EMT conduit, maximum not to exceed 96-inches on center; within 24-inches of each conduit bend and conduit termination location.
      2) FMC and LTFMC conduit, maximum not to exceed 24-inches on center; within 6-inches of each conduit bend and conduit termination location.
   c. Suspended conduit methods:
      1) Individual, suspended raceways/conduits separated by more than 12-inches from any other conduit and suspended from ceilings and roofs shall be supported as follows:

a) Conduits smaller than 1.5-inches by means of hanger rods or hanger wires.
b) Conduits 1.5-inches and larger by means of hanger rods.
c) The conduit shall attach to the hangers with pipe clamps.

2) Suspended raceways/conduits positioned within 24 inches of any other conduit shall be grouped and supported by hanger rods using trapeze type conduit support channels ("C" channels). Conduits shall individually attach to common channels side-by-side, with pipe clamps.

d. Non-suspended conduit methods:
1) Individual raceway/conduits placed against wall/ceiling/floors, placed inside hollow wall/ceiling construction or structure framing (i.e., “dry- wall” or plaster hollow wall construction), shall be secured by means of individual pipe clamps and fasteners attached to the framing studs or other structural members and the conduit/raceway.
2) Provide common “C" channel supports for all multiple raceway/conduits placed against vertical or horizontal surfaces and positioned within 24-inches of other raceways/conduits. Attach channels to the framing studs or other structural members. Attach the conduits/raceway individually to common channels, side-by-side, with pipe clamps.
3) The use of toggle bolts is prohibited.

e. Conduit rising from floor for motor connection shall be independently supported if extending over 18-inch above floor. Support shall not be to a motor or ductwork, which may transmit vibrations.

f. Provide conduit anchoring, conduit support and conduit bracing systems conforming to Earthquake Seismic Zone 4 requirements. The conduit support/ anchoring system capacity shall include the weight of the conduits, conduit fittings, conduit supports and conductors/wires/cables installed in the conduits plus a 300% safety factor. Submit shop-drawing details showing each typical conduit anchor, conduit support and conduit brace location. Submit structural calculations performed by and signed by a Professional Structural Engineer (P.E.) with a P.E. license, registered in the state of California, U.S.A.

2. Conduit separation:
a. Conduit installed underground or below building slab without full concrete encasement: Shall be separated from adjacent conduits of identical systems (i.e. signal to signal, data to data, power to power, control to control etc.) by a minimum of 3-inches. Conduits of non-identical systems (i.e. signal to power; data to power; power to control; signal to control, etc.) shall be separated by a minimum of 12-inches.

b. Conduit installed underground with full concrete encasement; shall be separated from adjacent conduits of similar systems (100 volt and less) by a minimum of 2-inches; conduits for non power systems (100 volts and less to ground) shall be separated by a minimum of 6-inches from power circuits (over 100 volts to ground); conduits for power circuits shall be separated from adjacent conduits of similar power systems (over 100 volts to ground) by a minimum of 3-inches.

c. Separation of conduits entering termination points or crossing other conduits may be reduced as required within 60-inches of the termination or crossing points.

d. Conduits containing Utility Company service circuits (i.e. electrical power, telephone, or cable television) shall be separated a minimum of 12-inches from all other utilities and conduits, with or without concrete encasement; metallic or non-metallic conduit, above grade or underground conduit locations.

e. Conduits shall be separated from hot water piping, exhaust flues/chimneys, steam piping, boilers, furnaces, ovens by a minimum of 12-inches.

3. Conduit stubs:
a. Branch circuit and telephone conduits turned up from floor at the following locations shall terminate each conduit in a flush conduit coupling at the floor and then extend into partition or to equipment. Refer to DISTRICT’S REPRESENTATIVE’S drawings for location of walls and partitions.
1) Interior demountable partitions.
2) Below, into or adjacent to equipment not installed directly adjoining to a wall.
3) Up from below the floor into hollow stud frame walls.

b. From each panel, and signal cabinet which is wall mounted, stub up from top of the panel/cabinet a minimum of (3) three 1-inch conduits to the nearest accessible ceiling

spaces or other accessible location. Where the floor below the panel is accessible or is a ceiling space, stub an additional (3) three 1-inch conduits from the bottom of the panel into the accessible space below the panel. Cap conduits for future use.

c. Conduits stubbed underground outside of building line for future use shall be terminated a minimum of five feet clear (whichever distance is greater) of building or adjacent concrete walks and AC paving. The stubout conduit shall be capped. Provide concrete monuments, 6-inches by 6-inches by 15-inches deep, buried flush with grade over the capped ends. The face of monument shall be furnished with 3-inch square brass plates securely mounted and engraved with the number and size of conduits and type of service (i.e., "POWER", "TEL.", etc.).

d. Conduits stubbed into ceiling or floor spaces from outlets for telephone, video, computer/data or television shall be provided with an insulated throat bushing, on the end of each conduit stubout.

e. Conduit stubouts from outlet boxes and equipment located in hollow stud walls, into ceiling and floor spaces, shall be EMT or RMC conduit. The stubouts shall terminate into the ceiling and floor spaces with a conduit termination connector fitting.

f. Empty conduit stubs into building spaces and equipment shall be individually identified with a “ID-tag” located at each end of the conduit. The ID-tag shall state the origination point and termination point of the respective conduit (i.e., “from PNL-A/to Room #121”; ”from outlet #24/to outlet #17 in Room #120”; etc.).

g. Provide a conduit termination fitting with insulated throat bushing and mechanical ground lugs at each conduit “stub-up” location.

4. Conduit concrete encasement:
   a. Conduits which are run underground exterior to building slab shall be continuously concrete encased except, 15 and 20-ampere power branch circuit conduits underground do not require concrete encasement.
   b. PVC rigid-non-metallic-type EB conduit, of any size and any location shall be continuously concrete encased the full length of the conduit installation, including under building slab.
   c. Concrete for encasement of underground conduits shall be 2000-PSI 28-days cure strength with a mix of cement, sand, water and maximum of ¾-inch gravel. Concrete encasement of conduits shall be continuous without voids. The encasement shall extend 3-inches past the edges of all conduits on all sides of the circuit. Provide ten pounds of red oxide cement coloring uniformly mixed with each cubic yard of concrete for conduit encasement.
   d. Conduits located below or adjacent to structural foundations shall be separated from the foundation by a minimum of 12-inches. Conduits located below structural foundations shall be fully and continuously concrete backfilled and encased between the bottom of the foundation to the bottom of the conduits. The concrete shall be 4000 PSI 28 day cure strength instead of 2000-PSI concrete.
   e. Conduits of any size and type (including 15 ampere and 20 ampere power branch circuits) located under roads, paved areas and “transit-system” right of way shall be concrete encased.
5. Underground conduits:
   a. Three or more underground conduits larger than 1-inch in size and occupying the same trench shall be separated and supported on factory fabricated, non-metallic, duct/ conduit support spacers. The spacers shall be modular, keyed interlocking type, "built- up" to accommodate quantity, size orientation and spacing of installed conduits. The spacers shall maintain a constant distance between adjacent conduit supports and hold conduits in place during trench backfill operations. Minimum support spacer installation interval along with length of the conduits shall be as follows:
      1) Concrete encased conduits, not less than 8-feet on center.
      2) Non-concrete encased conduits, not less than 5-feet on center.
   b. Provide trenching, excavation, shoring and Backfilling required for the proper installation of underground conduits. Tops of backfill shall match finish grade.
   c. Bottoms of trenches shall be cut parallel to “finish grade” elevation. Make trenches 12-inches wider than the greatest diameter of the conduit.
   d. Back-filling Trenches for Conduits without Concrete Encasement Requirements

1) Conduits which are not required by the Contract Documents to be concrete encased and are located exterior to building slab, shall be set on a 3-inch bed of damp clean sand. Conduit trenches shall be backfilled to within 12-inches of finished grade with damp sand after installation of conduit is completed. Remainder of backfill shall be native soil.
2) Conduits located under a building which are not required by the Contract Documents to be concrete encased, shall be completely backfilled and compacted with clean damp sand to the same level as the building foundation pad.
3) Provide a continuous yellow 12-inches wide flat plastic tracer tape, located 12-inches above the conduits in the trench. The tracer tape shall be imprinted with "Warning-Electric Circuits" a minimum of 24-inches on center.

e. Backfilling trenches for conduits under paved areas:
1) In addition to the requirements of conduit concrete encasement, conduits under walkways, roads, parking lots, driveways, and buildings shall be cast in place concrete "slurry mix" backfill. The slurry mix shall cover each side and top of conduits and conduit concrete encasement. The slurry mix shall be continuous to the underside of the finish subgrade surface.

f. Backfilling trenches for conduits with concrete encasement requirements by the contract documents:
1) Trenches with all conduits concrete encased, shall be backfilled with clean damp sand when located under building pads.
2) Trenches with all conduits concrete encased and not located under a building pad and not located under paved areas, shall be backfilled with clean damp sand or native soil.

g. Backfill material:
1) Sand and native soil backfill of trenches shall be machine vibrated in 6-inch lifts to provide not less than 90% compaction of backfill.
2) Soil backfill shall have no stones, organic matter of aggregate greater than 3-inches.
3) Concrete and slurry mix (2000-PSI) shall be machine vibrated during installation to remove "air-voids".
4) The slurry mix shall consist of concrete, clean rock, clean sand and clean water mixture. Maximum shrinking of slurry mix shall not exceed 5% wet to dry.

h. Do not backfill until District's Representative has approved installation and as-built drawings are up to date. Promptly install conduits after excavation has been done, so as to keep the excavations open as short a time as possible. Excess soil from trenching shall be removed from the site.

i. Install underground conduit, except under buildings, not less than 24-inches below finished grade in non-traffic areas and 30-inches below finished grade in traffic areas, including roads and parking areas. Not less than 48-inches below finished grade under public/ private transit system right of way and railroad right of way. Dimensions shall be measured to the top of the conduit.

j. Conduit crossing existing underground utilities shall cross below the bottom depth of the existing utilities. If the top portion of the existing utility depth below finish grade exceeds 72-inches and the specified separation and depths are maintained when crossing over the top of the existing underground utility, the conduit may cross above the existing underground utility.

k. Provide long radius horizontal bends (minimum radius of 36-times the conduit diameter) in underground conduits where the conduit is in excess of 100-feet long.

l. Conduits installed below grade and on grade below buildings, shall not be smaller than 0.75-inches. Conduits for circuits exceeding 600-volts shall not be smaller than 5.0-inches.

m. Underground conduits entering a building shall be sloped. The conduit direction of slope shall be away from the building, and shall prevent water in the conduit from "gravity draining" towards the building. The conduit slope "high point" shall originate from the building, out to the first exterior pullbox, manhole etc. exterior conduit termination "low point". The minimum slope angle shall be a constant 8-inches (or greater) of fall for each 100-feet of conduit length.

n. Dewatering:
   1) Provide pumping to remove, maintain and dispose of all water entering the excavation during the time the excavation is being prepared, for the conduit laying, during the laying of the conduit, and until the backfill at the conduit zone has been completed. These provisions shall apply on a continuous basis. Water shall be disposed of in a manner to prevent damage to adjacent property. Trench water shall not be drained through the construction. Groundwater shall not be allowed to rise around the pipe until joining compound has firmly set.
   2) The DISTRICT'S Representative shall be notified 48 hours prior to commencement of dewatering.

6. Raceway/Conduits, which are installed at this time and left empty for future use, shall have 0.25-inch diameter polyvinyl rope left in place for future use. The pull rope shall be 500-pound minimum tensile strength. Provide a minimum of 5-feet of slack at each end of pull ropes.

7. Unless otherwise restricted by structural drawings and specifications, the maximum size conduit permitted in concrete slab on-grade, walls, ceilings and roofs constructed of masonry or concrete shall not be greater than 20% of the concrete/masonry thickness. Conduits installed in these locations shall not cross.
   a. Conduits shall not be installed in cast-in-place concrete floors.
8. Provide openings in building structures for conduit penetrations:
   a. New construction shall be provided with conduit sleeves, to provide conduit penetrations.
   b. Existing construction shall be drilled (core drill masonry and concrete) and provide conduit sleeves installed after drilling, to provide conduit penetrations.
   c. Where the structure penetrations for underground conduits penetrating through foundations will not comply with the (restriction/penetration) shown in the Contract Documents, install the conduits below and clear of the foundation lowest point.
9. Conduit bends risers and offsets:
   a. The minimum bend radius of "factory or field" fabricated conduit bends shall not be less than the following. The bend radius shall be measured at the surface, inside radius of the conduit wall:
      1) FMC and LTFMC conduit - conduit minimum bend radius 12-times the conduit diameter.
      2) RMC and EMT conduit minimum bend radius - conduit for power circuits over 100 volts and less than 600 volts, 8-times conduit diameter. Conduit for power circuits over 600 volt, 12-times conduit diameter. Conduit for low voltage, signal and fiber optic circuits, 10-times conduit diameter.
      3) RNMC conduit - conduit minimum bend radius 36-times the conduit diameter. Under building reduce minimum bend radius to 10-times the conduit diameter. Conduit bends and offsets in RNMC with less than 36-times conduit diameter bend/offset radius, shall be RNMC PVC schedule 80 or PVC coated RGS.
      4) Conduits for utility company conductors. Conduit minimum bend radius shall comply with the respective utility company requirements.
   b. Bends and offsets in conduits shall be kept to an absolute minimum. The total summation of all bends and offsets permitted in a conduit segment, occurring between two conduit termination/ connection end points, shall not exceed the following, including conduit fittings:
      1) RMC and EMT conduit - 360 angular degrees
      2) FMC and LTFMC conduit - 180 angular degrees
      3) RNMC conduit - 270 angular degrees
   c. Each field fabricated conduit offset, bend and elbow which are not the standard product of the raceway/conduit manufacturer shall be mandrel tested. The test shall be conducted after the conduit installation is complete and prior to pulling-in any wire, in the same manner as for underground conduits.
   d. Factory manufactured angle connector conduit fittings shall be installed in exposed conduit locations only. Installation in locations normally concealed from view shall not be permitted. Not more than one (1) factory manufactured angle connector shall be permitted in any length of conduit between conduit termination end points.

e. RNMC conduit risers from below grade shall be PVC coated RGS. Conduit risers, bends or offsets entering into a building shall be PVC coated RGS.

f. If three (3) or more conduit-bends of the same conduit size and same conduit material type, installed, as part of the contract work, fail to comply with the required minimum conduit bend radius or conduit angular degree limits. The following corrective actions shall occur:

1) The CONTRACTOR shall remove all the non-complying conduit bends and the respective wire in the conduit from the project site. Provide new conduit and wire, complying with the contract documents.

2) Where the conduit bends similar to the non-complying conduit bends are installed concealed in walls, floors, above ceilings or below grade, the Contractor shall expose the conduit bends to allow visual observation.

3) The CONTRACTOR shall remove the non-complying conduit bends and dispose off the project site. The CONTRACTOR shall provide new conduit bends and conductors complying with the contract documents.

4) All the costs to correct the deficient material and work along with costs to repair the direct, indirect, incidental damages and contract delays shall be the sole responsibility of the CONTRACTOR and shall be included in the bid price.

10. Expansion joint, deflection joint and seismic joint fittings.

a. Provide a conduit expansion fitting for each conduit length and conduit type as follows (Note - The installation of specified combination expansion/deflection fittings at seismic joints shall satisfy this spacing requirement also):

	Conduit Type	Conduit	Fitting Length Spacing
1)	RMC and EMT	Exposed exterior locations	200-feet
2)	RMC and EMT	Interior weather protected locations	400 feet

b. Provide a conduit combination expansion/deflection fitting for each conduit, crossing the following elements:

1) At each building or non-building structure seismic joint.

2) At each building on non-building structure expansion joint.

3) At each conduit penetration of a “sound-rated” wall, floor or ceiling.

11. Provide two (2) locknuts and an insulated throat bushing at each metal conduit terminating at enclosures, including but not limited to outlet boxes, junction boxes, terminal cabinets, switchgear, transformers, switchboards, distribution panels and panelboards.

12. Provide metallic or plastic closure caps on all conduit ends during construction, until installation of conductors in the respective conduit.

13. Conduit run exposed, shall be run at right angles or parallel to the walls or structures. All changes in directions, either horizontally or vertically, shall be made with conduit outlet bodies as manufactured by Crouse Hinds, OZ or equal. Conduits run on exposed beams or trelliswork shall be painted to match surrounding surfaces.

14. Conduit exposed on roof:

a. Conduits installed exposed on roofs shall be limited on the project and be approved by Architect beforehand. When approved, they shall be installed on conduit sleepers. Place the conduit sleepers a maximum 5-foot on center along the entire length of the conduit; under conduit expansion/deflection fittings; under each junction box and within 24- inches of each conduit bend.

b. Provide a conduit support “C” channel continuous along the top length of the sleeper and rigidly bolted to the sleeper. Conduits shall be loosely fastened to each sleeper “C” channel with pipe clamps to allow for relative movement between the sleeper and conduit.

c. Conduits shall not block or interfere with roof hatches, doors, ventilation openings, dampers, equipment access panels/doors, roof water drainage.

e. Conduit sleepers shall be fabricated, MIFAB C-Port Rubber Support or MIRO Industries with Polycarbonate base, or equal. Sleeper length shall extend a minimum of 9-inches past the conduits attached to the sleeper, but in no case shall the length of the sleeper be less than 24- inches.

f. Provide a pad under each sleeper, sleepers shall not be installed in direct contact with the roofing. Sleeper pads shall extend a minimum of 6 inches past each side of the sleeper. The sleeper pad shall be semirigid mineral surfaced composition board, not

less than 0.375-inch thickness, bituminous impregnated, manufactured for application on the specific roofing material. Remove roofing "ballast" (gravel) under pad, prior to installation of sleeper pad. Do not puncture roof membrane.

g. Position the "length" of the conduit sleepers' perpendicular to the roof slope, to prevent obstruction of roof drainage water flow. Where the conduit routing prevents placing the conduit sleeper parallel to the roof slope, provide two separate sleeper pads for the conduit sleeper, with a continuous 3-inches wide water drainage gap between the sleepers. Align the water drainage gap to allow unimpeded water travel along the roof slope drainage flow line between the pads.

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15. Rigid steel conduit or electrical metallic tubing shall not be strapped or fastened to equipment subject to vibration or mounted on shock absorbing bases.
16. RMC conduit threads:
    a. Machine cut threads on RMC conduit required for field fabrication shall comply with NPS and ANSI-
    B1.20.1.
    b. The length of bare metal exposed during thread fabrication shall be completely covered by conduit couplings and fittings. Additionally, the thread length shall insure that conduit joints will reach "torque" tightness and become secure before conduit ends "butt" together and before conduit ends "butt" into the "shoulders" of other conduit fittings.
    c. Running threads or right/left handed threads shall not be used to connect RMC.
17. RNMC conduit:
    a. Joints and fittings shall be solvent welded to RNMC conduit. Joints and fittings shall be watertight and airtight after fabrication.
18. Tighten each conduit fittings and fitting appurtenance, to the "torque" (allowable tolerance 5%) value recommended by the fitting manufacturer and applicable code. If three (3) or more conduit fittings are found to not be in compliance with the manufacturer's "torque"
    (tightness) recommendations, the following corrective actions shall occur:
    a. The CONTRACTOR shall tighten "re-torque" the defective fittings and all similar conduit fittings installed as part of the contract documents in the presence of the District's Representative.
    b. If the respective conduit fittings similar to the deficient "torque tightness" fittings are installed concealed in walls, floors, above ceilings or below grade, the CONTRACTOR shall expose the fitting, to allow retightening each similar conduit fitting to the manufacturers recommended "torque" values.
    c. All the cost to repair the direct, indirect, incidental damages and contract delays resulting from complying with these requirements shall be the sole responsibility of the CONTRACTOR and shall be included in the bid price.
19. Horizontal directional boring for underground conduit:
    a. Provide a directional guided horizontal "bore-hole" underground conduit installation where one or more of the following conduits occur:
        1) Continuous trenching excavation and backfill for conduit installation is not permitted by the contract.
        2) Where continuous trenching excavation due to the existing surface and below grade conditions and restrictions, is not possible or practical to excavate a trench.
    b. Provide "path-tracing" of the underground bore head, from the surface, along the entire horizontal bore length. Path tracing shall use electronic transmitters and receivers, continuously communicating the underground bore head locations and depth to the bore equipment operator. The directional boring system shall employ active tracking and directional position/steering control of the bore equipment drill head location. The active tracking system shall provide a portable receiver/transmitter unit for tracking the position of the moving drill head; a sensor "Sonde" unit on the drill head for tracking signals to the receiver /transmitter; and a drill head tracking data view display located at the boring equipment operator position to view the drill head position information sent

from the portable receiver/ transmitter. As manufactured by SPX-Radiodetection Company or similar products.

c. Provide vertical pilot excavations not more than 50-feet on center along the path of the bore-hole to intercept the horizontal bore-hole routing, provide excavations at the beginning and end terminals staging points of the horizontal bore-hole.
d. Provide full-depth “shoring” of the vertical pilot excavations. Remove the shoring, backfill, compact and repair the excavations when conduit installation is complete.
e. “Drilling-fluid” shall be used during “back-reaming” and “pullback”, pumped through the drill pipe to the bore drill head.
f. Directional guided horizontal drilling shall employ equipment specifically designed and manufactured for the process. The equipment manufacturer shall train bore equipment operating personal in the proper operation of said equipment.
g. Locate the position, size, depth and identify all underground “cross-bore” existing underground utilities, pipes, structures and conflicts along the entire bore path of each underground bore, prior to initiating directional boring work. Notify respective agency for each “cross bore” potential crossing. Comply with the recommendations of the Cross Bore Safety Association (CBSA).
h. Horizontal, directionally guided boring equipment, as manufactured by Ditch Witch; Vermeer Manufacturing; or Case Corporation.

J. Conduit Seals
1. Provide conduit seal fittings at each location where a conduit transitions or passes through the following areas and where indicated on the drawings:
a. Refrigerated areas.
b. Temperature control rooms including warming rooms, steam rooms, saunas etc.
c. Classified hazardous material areas.
d. Water intrusion areas.
2. Provide conduit seals on each conduit entering a building from a below grade area located outside the building (i.e., basement, vault etc.) and connecting to the following types of equipment
a. Transformers
b. Panelboards
c. Motor control centers
d. Switchboards
e. Switchgear
f. Motors
g. Terminal cabinets
h. Terminal backboards
i. Cable trenches
3. Conduit seals shall be installed in locations where the fitting is visible and accessible.

K. Nailing Shields
1. Provide “nail” shields where FMC conduit and conductors not installed in a conduit are installed through wood stud and wood frame construction. The nail shield shall provide a barrier resistant to “nailing” fasteners through the stud, and penetrating into the FMC and conductors.
2. The nail shields shall be flat nominal 1.5-inch x 3-inches, 14-gauge steel, and hot dip zinc galvanized with “nailing spurs”.
3. Provide nailing shields on the front face and rear face of each FMC penetration. The shield shall be centered on each penetration through the respective framing, stud framing blocking, and stud framing plates.

L. Conduit Bodies
1. Conduit bodies shall be installed in exposed conduit locations only or above accessible ceilings.
2. Conduit bodies shall be accessible for removing body cover and pulling wire through the conduit body.
3. Conduit bodies shall not be installed inside enclosed walls.

M. Preparation of Reuse of Existing Conduits
   1. Prepare existing conduits shown to be reused as part of contract work as follows: Complete the required work prior to installing any conductors or cables in respective existing conduits.
      a. “Rod” out existing raceways to be used under this contact, with approved test and flexible mandrels to remove all obstructions to clear debris from inside conduits.
      b. Use test mandrels at least 12-inches long, 0.25-inches less than diameter of duct at center, tapering to 0.5-inches less than duct size at ends.
   2. If test mandrels cannot be pulled through raceways, CONTRACTOR shall perform the following to clear the existing raceways:
      a. Force rigid or semi-rigid rods through the raceways to clear the obstructions from one to both ends of the raceway.
      b. Force a power driven rotating router device through the conduit from one or both ends of raceways. Device shall incorporate small diameter cutting blades. Repeat the “router” process in incremental stages to a cutting blade diameter approximately ⅛-inch smaller than the raceway inside diameter.
   3. After clearing the raceway of obstructions, pull a test mandrel or brush through the raceway to clear the remaining debris from the raceway.

3.04 WIRE AND CABLE

A. Branch circuit and fixture joints for #10AWG and smaller wire shall be made with UL-approved connectors listed for 600 volts, approved for use with copper and/or aluminum wire. Connector to consist of a cone-shaped, expandable coil spring insert, insulated with a nylon shell and two (2) wings placed opposite each other to serve as a built-in wrench or shall be molded one-piece as manufactured by 3M-"Scotchlok".

B. Branch circuit joints of #8AWG and larger shall be made with screw pressure connectors made of high strength structural aluminum alloy and UL-approved for use with both copper and/or aluminum wire as manufactured by Thomas & Betts. Joints shall be insulated with plastic splicing tape, tapered half-lapped and at least the thickness equivalent to 1.5-times the conductor insulation. Tapes shall be fresh and of quality equal to Scotch.

C. Use UL listed pulling compound for installation of conductors in conduits.

D. Correspond each circuit to the branch number indicated on the panel schedule shown on the drawings except where departures are approved by the DISTRICT’S REPRESENTATIVE or the DISTRICT’S Representative.

E. All wiring, including low voltage, shall be installed in conduit.

F. Control wiring to conform to the wiring diagrams shown on the mechanical drawings and the manufacturer's wiring diagrams.

G. All splices in exterior pull boxes and light poles shall be cast resins encapsulated.
   1. Power conductor splices - 3M Scotchcast Series 82/85/90; Plymouth or equal.
   2. Control and signal circuits 3M Scotchcast series 8981 through 8986, Plymouth or equal.

H. Neatly group and lace all wiring in panelboards, motor control centers and terminal cabinets with plastic ties at 3-inch on centers. Tag all spare conductors.

3.05 CHEMICAL GROUND ROD

A. General
   1. Install ground rod system in compliance with manufacturer's instructions.
   2. Install rods vertically. Where subterranean hard rock conditions prevent vertical installation horizontal "L" shape ground rod shall be installed.

   3. Where ground rod is installed in an indoors dry location set ground box flush with finish floor. Where ground rod is installed outdoors set the top of the ground box four inches above finish grade.
   4. Do not remove sealing tape from ground rod holes until time of installation in ground.

5. Separate ground rods from all other grounding electrodes and from each other by not less than 12-feet horizontal distance.

B. Excavation
   1. Vertical installation bore a 12-inch diameter vertical hole in the ground six inches deeper than ground rod length.
   2. Horizontal installations excavate a 12-inches wide trench, slope rod and trench to insure end cap of rod is 2-inches lower than the elbow.

C. Backfill
   1. Surround the entire rod with a minimum of 10 inches of bentonite clay mixed with water at six times volume to form a paste. Approximately 14-gallons for each 50-pounds of clay. Remove any excavation liners from the rod excavation area.
   2. Install ground box and complete backfill.

D. Connect grounding electrode conductor(s) to ground rod.

3.06 CABLE RACKS

A. General
   1. Provide cable racks in precast and cast-in place concrete pullboxes, manholes and cable trenches, and ensure that all cables, conduits, or conductors of line or high voltage, are neatly assembled and are a minimum of 4" from the bottom of the boxes.

3.07 TESTING

A. Testing Conduit and Conduit Bends

The CONTRACTOR shall demonstrate the usability of all underground raceways, and field fabricated conduit bends installed as part of this contract.

   1. A round tapered segmented semi-rigid mandrel with a diameter approximately ¼-inch smaller than the diameter of the raceway, shall be pulled through each new raceway.
   2. The mandrel shall be pulled through after the raceway installation is completed. Conduits which stubout only, may have the mandrel pulled after the concrete encasement is completed, but prior to completing the backfill.
   3. DISTRICT'S REPRESENTATIVE shall witness the raceway testing for usability. A Representative of the Respective Utility Company shall witness the raceway testing where applicable.
   4. CONTRACTOR shall repair/replace any conduit and conduit bend provided under this contract which will not readily pass the mandrel during this test.

END OF SECTION

SECTION 26 05 36
CABLE TRAY

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 (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all cable trays, all related components, and NEMA VE1.

B. Submit cable tray support details.

C. Provide reproducible floor plan shop drawings, with the same scale as the contract floor plan drawings. The drawings shall show the proposed cable tray layout plan views. A elevation view shall be provided at each riser or change in horizontal elevation in the cable tray. The shop drawing plans shall show all building elements, expansion/seismic joints, air ducts, piping and components that cross the path of the cable tray, along with separation of the cable tray from the crossing components.

PART 2 - PRODUCTS

2.01 CABLE TRAY

A. Material and installation shall comply with NEMA - "VE1" latest edition, Cable Tray Systems', N.E.C., California Title 24 and Title 8. As manufactured by Globe Tray, Chalfant, P-W Industries or equal.

B. Cable tray shall include two (2) longitudinal side rails, ladder type, with transverse 6 inches rung spacing welded to side rails. Rungs shall have a minimum cable-bearing surface of 0.75-inches. Rungs shall not extend below bottom of side rails. Splice plates shall be locking bolt type to connect tray sections together without decreased tray strength. Provide expansion/ deflection fitting at each building seismic and expansion joint crossing.

C. Trays shall be steel or aluminum. Steel trays shall be hot dip galvanized after fabrication ASTM A 123 with ANSI type 304 and 316 stainless steel hardware. Aluminum trays shall be extruded from 6063-T6-aluminum alloy with 5052-H32-aluminum alloy hardware.

D. The complete cable tray system and supports shall be designed for the following minimum uniformly distributed working load but not less than indicated on the drawings, with a 1.5 minimum safety factor, when supported as a single span. In addition, the cable tray shall support 200 pounds concentrated at span midpoint without permanent distortion.
   1. Cable tray wider than 12-inches or deeper than 6 inches, live loading 200 pounds per linear foot.
   2. Cable tray 12-inches or less in width and 6 inches or less in depth live loading 100 pounds per linear foot.

E. Provide ladder type "elbows", "tees", horizontal "crosses", expansion connectors, reducer sections, connectors, straight sections, curved sections, fittings, supports, hangers, blind ends,

risers and accessories to provide a complete installation of the cable tray shown on the drawings. Provide trapeze brackets and individual threaded hanger suspension rods in any

combination required to support the cable tray system. Provide all materials and labor necessary for a complete installation.

F. Cable tray runs shall be minimum 6-inches deep by 12-inches wide, but not less than indicated on drawings. Dimensions are outside dimensions of the cable tray rails.

G. Similar cable tray parts and hardware shall be interchangeable with each other. The cable tray system shall be free of sharp edges, burrs or projections that can damage cable insulation.

PART 3 - EXECUTION

3.01 CABLE TRAY

A. Cable trays shall be seismically anchored and supported to the building structure to prevent horizontal or lateral movement with 1.0-gravity acceleration, including specified live load conductor capacity, complying with State of California seismic codes. Support hangers from the building structure shall provide a 2.0 weight carrying safety factory including specified live cable weight. Cable tray hangers shall be provided with a spacing to insure the maximum cable tray deflection with the specified live cable loading does not exceed 0.75-inches between supports and hangers. In no case shall cable tray support or hanger spacing be greater than 12-feet on center.

B. Punching or drilling of structural side members shall not be performed except for splice plate bolt-holes.

C. Provide expansion adapters where cable trays cross a building expansion joint, and to comply with tray manufacturer's recommendation for the cable tray thermal expansion requirements.

D. All cable trays including non-connected tray sections shall be made electrically continuous. Provide grounding jumpers minimum equivalent to #8AWG, where required to provide continuity.

E. Grounding for cable trays shall comply with Article 318-6 of NEC.

F. Provide curved "radius" cable trays at each "horizontal" or "vertical" change in direction of the cable tray. Provide "tee" and "crosses" at each intersection of cable trays. Provide "blind ends" at the end of each cable tray "run".

G. Provide removable fire blocking "bagstyle" at cable tray penetrations of fire barriers.

END OF SECTION

SECTION 26 05 43

PULLBOXES

PART1 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 (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all racks, hooks, supports, ladders, covers, grounding, manholes, vaults, pullboxes, joint sealing compound etc.

B. Submit detailed shop drawings including dimensioned plans, elevations, details, structural calculations signed by a California State registered Structural ENGINEER and descriptive literature for all component parts.

PART 2 PRODUCTS

2.01 GENERAL

A. Each concrete precast section shall be identified by having the manufacturer's name and address, along with respective section weight cast into an interior face or permanently attached thereto. Associated Concrete Products, Jensen Precast Products, Brooks Products or equal.

B. Structure Construction
   1. The precast steel reinforced concrete structure walls, floor and roof shall safely sustain the loads and pressure resulting from vertical and lateral earth loading and vehicular loading. Based on the following criteria:
      a. Minimum earth density shall be 120 lbs./cu.ft.
      b. Minimum equivalent fluid pressure for lateral pressure due to earth shall be 85 lbs./sq.ft. undrained earth conditions, minimum safety factor for buoyancy shall be 1.25.
      c. Vehicular load rating shall be H-20 in compliance with latest AASHO specifications.
      d. Design shall be based on maximum depth of fill over the structure as indicated on the drawings, but not less than 36 inches.
      e. Design and details shall comply with minimum ACI 318-63 code requirement. Minimum concrete 28 day cure strength shall be 3,000 psi.
   2. Precast structure shall be designed to withstand forces due to additional inward load of 4,000 pounds (working load) with safety factor of two (2), acting perpendicular to the surface at any pulling iron.
   3. Structures shall be single piece or horizontal multi-section construction as required for field installation conditions. Multi-sections shall interlock with "Tongue and groove" joint mating surfaces to insure a rigid assembly.
   4. All structure precast joints shall be sealed with preformed cold field applied plastic joint sealing compound. Joint sealing compound shall not leak, sag or flow at the joints with 10 psi water pressure applied for 24 hours. Chemically resistant to acid, alkali's and saturated hydrogensulfide.
   5. Each precast structure section shall have suitable knockouts or openings in the vertical walls for the duct banks and conduits entering the structure. Provide a 1 inch diameter

knockout in each corner of the floor slab, 6 inch from adjacent walls, for installation of ground rods.

C. Intercept Manhole/Pullbox Structures
   1. Intercept type manhole/pullbox structures shall comply with the requirements of non intercept manholes and pullboxes, respectively. Plus the additional requirements listed below.
   2. Manholes/pullboxes shown to be installed at the same location as replacement for existing manhole/pullbox shall be custom fabricated "intercept" multi-section type.
   3. The structure shall be provided with multiple, vertical and horizontal custom fabricated sections for fitting around existing manholes/conduits/duct banks/conductors entrances into the structure during manhole installation without disturbing existing manholes/pullboxes. The structures shall allow placement of the structures without disconnecting or disrupting existing circuits during the installation. The structure walls shall be slotted to fit around existing concrete encased conduit entrances.
   4. Provide cast-in-place concrete steel reinforced foundation/footings and floor for the intercept structure. The foundation shall be installed prior to removal of existing manhole/ pullbox. The floor shall be installed after removal of the existing manhole/pullbox structure. The foundation/footing and floor shall be designed, and engineered as part of precast structure.
   5. The structure foundation/footings shall be "keyed" to match keying of manhole precast wall sections.

2.02 PULLBOXES

A. Pullboxes shall have deep recess conduit knockout concrete extensions at two opposite end walls. Additional shallow recess knockouts shall be provided on the other two walls for conduit entrances.

B. Pullboxes shall be provided with a minimum of one precast concrete 6 inch extension grade ring "tongue and groove" matting surfaces to insure rigid assembly.

C. Pullbox sizes shall be as indicated ori drawings but in no case less than required by applicable codes. Minimum depth of the pullbox shall not be less than 42 inch.

D. The pullbox floor sump shall extend through the concrete floor into the gravel bedding, below the pullbox.

2.03 COVERS AND FRAME ASSEMBLIES

A. Traffic rated per AASHO for H20 loading.

B. Pullboxes
   1. Hot dip galvanized steel single piece flush fitting with threaded flush hold down, slotted head, stainless steel studs.
   2. Topping frame shall be hot dip galvanized steel angle frame where the pullbox is installed in paving or concrete work.
   3. Top ring frame shall be armor band type where the pull box is installed in exposed earth or landscaping.
   4. Cover openings larger than eight (8) square feet of surface area, shall be provided with "split" two (2) piece cover type. Each "split" cover shall be hinged open-close with Torsion Spring type cover, to assist in the ease of opening and closing the cover.
   5. Cover openings eight (8) square feet or smaller surface area shall be single piece covers.

C. Covers shall be permanently marked in the cover metal as follows:
   1. "E" or "Electric" for covers on structures containing power circuits under 600 volts and "HV" or "High voltage" for covers on structures containing power circuits over 600 volts.
   2. "Signal" for covers containing signal circuits.

2.04 CABLE RACKS

A. Cable racks, installed on the vertical walls of the structure, including hooks and porcelain insulator cable cradles, shall be sufficient to accommodate the cables and splices.

B. Vertical racks shall be installed on all walls of the structure a minimum of 24-inches on center within 6-inches of floor and top of wall. A rack shall be installed within 18-inches of each corner of each wall. Additional racks spaced equally on each wall shall be installed, spacing between vertical wall racks shall not exceed 24 inches.

1. Wall racks shall be slotted to accept removable hooks and lock hooks into place.
2. Non-metallic, 50 percent (minimum) glass reinforced nylon or non-metallic material of the same characteristics.
3. The installed cable racks, cable support hooks with arms and wall anchor bolts shall support the following minimum loads for each hook/arm, with a 2000 percent minimum safety factor. Based on multiple hook/arms located not less than 9-inches on center along the entire vertical length of the support rack:

Hook/Arm Length	Minimum Weight Each Hook/Arm Supported	Maximum Allowable Hook/Arm Deflection
a. 8-inch	450 pounds	0.25-inch
b. 14-inch	350 pounds	0.37-inch
c. 20-inch	250 pounds	0.37-inch

(Based on load, concentrated 1-inch from the end of each hook/arm.

4. Racks shall be bolted to the precast and cast-in place structure walls, within 3-inches of each rack end and not less than 9-inches on center. Provide cast-in place or after set drilled expansion concrete anchors.

2.05 PULL-IN-IRONS

A. Pull-in-irons shall be a galvanized steel bar bent in a "U" shape, and cast in the structure walls and floors.

B. A floor pull-in-iron shall be centered under the manhole entry ring in the structure floor.

C. Pull-in-irons shall not be less than 6 inches above or below, in the opposite wall from each knockout panel for conduiUduct entrances.

D. Pull-in-irons shall project from the structure wall into the structure approximately four inches.

2.06 DRAINAGE SUMPS

A. Provide drainage sump with cast iron metal grate in the floor of each structure. Minimum diameter of 12-inches by 4-inches deep. Provide a removable cast iron grate over the sump.

PART 3 EXECUTION

3.01 EXCAVATION

A. Excavate for installation of precast structures removes excess excavated material from the site. Saw cut existing paving and concrete as required for excavation.

B. Provide a minimum of 6-inches deep bedding base of crushed rock 3/8-inch - Y:!-inch size in the bottom of the excavation. Bedding shall be level and well compacted by a minimum of four passes with a plate type mechanical vibrator.

C. Back fills and compact earth around precast structure after installation of the structure to 90-percent minimum compaction in 12-inch lifts. Replace paving concrete, landscaping above structure to match existing.

3.02 INSTALLATION

A. Install precast structures per manufacturer recommendations to provide a dry watertight installation. Set cover flush with existing grade or finish surface. Where precast structure is installed in pedestrian walkway or vehicular traffic way with a sloping finish grade. Slope cover to match existing finish surface slope.

B. Install structures to avoid surface water drainage flow lines, and existing utilities.

C. Exterior concrete walls tops and bases of precast structure shall be damp-proofed with two coats of a bituminous damp-proofing material, minimum finish thickness 4-mil.

D. Connections to Precast Structure
   1. Lines connecting to precast structures shall be constructed to have a cast in place concrete tapered section adjacent to the structure and extending a minimum of 48 inch out from the structure to provide shear strength.
   2. Precast structure shall be constructed to provide for keying the concrete envelope of the conduiUduct line into the wall of the structure. Mechanical vibrators shall be used when this portion of the envelope is poured to assure a seal between the envelope and the wall of the precast structure.

E. Entrances of conduits/ducts shall terminate with endbells inside the precast structure. Slope conduit entrances into manhole to insure top of conduit entrances into manhole are a minimum of 6-inches below manhole ceiling. Maximum conduit slope shall not exceed 1-inch per "running" foot of conduit.

F. Manholes and pullboxes shown to intercept existing conduit, remove portion of existing conduit approximately 4-feet back from manhole wall, regrade and excavate conduit entrance and extend existing conduit into manhole or pullbox to match existing conduit quantity and size. Provide "horizontal, split" conduit and split conduit coupling to extend existing conduit into manholes and pullboxes.

3.03 GROUNDING

A. Provide 10-feet long by 0.75-inch diameter copper clad, steel, driven ground rods through the floor of the precast structure. Provide a minimum of two ground rods in opposite corners in manholes and vaults, one ground rod in pullboxes. Ground rod shall extend 6-inches above the floor line. Where rock bottom is encountered, bury ground rod in horizontal trench with projection into precast structure. Seal off openings around ground rods.

B. Ground permanently and effectively together all metal equipment cases, metallic, cable racks, ladders, etc., with #4 bare copper bonding conductor. Provide U.L. compression bonding fittings at each ground connection.

END OF
SECTION

SECTION 26 08 00

ELECTRICAL LIGHTING SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Section Includes:

1. General requirements for Commissioning (Cx) of lighting systems components and lighting controls including installation, start-up, testing and documentation according to Construction Documents and Commissioning Plan (CxP).
2. Standard procedures for the execution of commissioning work shall be in conformance with Division 1, Section 01 91 00 General Commissioning Requirements. Coordinate all work with the Commissioning Agent (CxA).

1.2 RELATED SECTIONS:

1. Provisions of Division 01 apply to this section.
2. Section 01 91 00: Commissioning.
3. Section 01 78 23: Operations and Maintenance Data Training.
4. Section 26 05 00: Common Work Results for Electrical.
5. Section 26 05 01: Electrical General Provisions.
6. Section 26 09 23: Lighting Control Systems.
7. Section 26 50 00: Lighting Fixtures.
8. Project Commissioning Plan.

1.3 REFERENCES

A. Applicable codes, standards, and references: all inspections and tests shall be in accordance with the following applicable codes and standards, except as provided otherwise herein:

1. National Electrical Testing Association – NETA.
2. National Electrical manufacturer's Association – NEMA.
3. American Society for Testing and Materials – ASTM.
4. Institute of Electrical and Electronic Engineers – IEEE.
5. American National Standards Institute – ANSI.
6. National Electrical Safety Code – NESC.
7. California Building Code – CBC.

8. California Electrical Code – CEC.
9. Occupational Safety and Health Administration – OSHA.
10. National Institute of Standards and Technology – NIST.
11. ANSI/NFPA 70 – National Electrical Code.
12. NFPA 70E – Electrical Safety Requirements for Employee Work Places.
13. ANSI/NFPA 101– Life Safety Code.

1.4 SUBMITTALS

A. Submittals shall include the following:

1. Submit required Cx submittals in accordance with Division 1 Specification Sections.
2. Copy of the Architect's reviewed and accepted submittals to the CxA via the OAR.
3. List of team members who will represent the Contractor in the Pre-functional Equipment Checks and Functional Performance Testing, at least two (2) weeks prior to the start of Pre-functional Equipment Checks.
4. Detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, checklist documentation and field checklist forms to be used by factory or field technicians, and a copy of full details of Owner-contracted tests, full factory testing reports, if any, and Warranty information, including responsibilities of Owner to keep Warranty in force, clearly defined.
5. Detailed manufacturer's recommended procedures and schedules for Pre-functional Equipment Checks, supplemented by Contractor's specific procedures, and Pre-functional Tests, at least four (4) weeks prior to the start of Pre-functional Performance Tests.
6. After facility's commission is complete, submit all completed Pre-functional Equipment Checklists and Functional Performance Test checklists organized by system and by subsystem. Bind all information in a single package. The results of failed tests shall be included along with a description of the corrective actions taken.

1.5 MEETINGS, SEQUENCING AND SCHEDULING

A. Meetings: Attend (Cx) meetings as required under Section 01 91 00 and the Cx Plan.

B. Sequencing and Scheduling: The work described in this Section shall begin only after all work required in related Division 26 Sections has been successfully completed, and all tests, inspection reports and Operation & Maintenance manuals required in Division 26 Sections have been submitted and approved. The start-up and Pre-functional Equipment Checklists shall be completed and submitted to the Owner's Authorized Representative (OAR) prior to the Functional Performance Tests. Refer to the project Cx Plan for more details.

1. Coordinate all electrical work with the work of other trades prior to

scheduling of any Cx procedures.

2. Coordinate the completion of all electrical testing, inspection, and calibration prior to start of Cx activities.

3. Cx activities shall be scheduled in accordance with project's Cx plan.

1.6 QUALITY CONTROL

A. Incorporate manufacturer's recommended Cx procedures for the systems and equipment to be commissioned under this Section.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Equipment to be utilized in the commissioning process shall meet the following requirements:

1. Provide test equipment as necessary for the equipment and systems to be commissioned.

2. Provide testing equipment and accessories that are free of defects and certified for use.

3. Provide testing equipment with current calibration labels per NIST Standards.

4. All testing equipment shall be UL Listed.

PART 3 – EXECUTION

3.1 COMMISSIONING PROCESS REQUIREMENTS

A. Work to be performed prior to commissioning:

1. Complete all phases of the work so the system(s) can be started, tested, adjusted, balanced, and otherwise commissioned.

2. If modifications or corrections to the installed systems are required to bring the system(s) to acceptance levels due to Contractor's incorrect installation or defective materials, such modifications or corrections shall be made at no additional cost to the Owner.

B. Pre-commissioning Responsibilities: Inspection, calibration and testing of the equipment and apparatuses to commission the following systems:

1. Electrical Lighting Systems.

2. Lighting Controls.

C. Commissioning Process Requirements:

1. Refer to Section 019100 General Commissioning Requirements, related sections and Cx Plan for information on meetings, start-up plans, Pre-

Functional and Functional Performance Testing (FPT), operations & maintenance data, and other Commissioning activities.

3.2 PREPARATION

A. Provide certified electricians or other qualified personnel as required with tools and equipment necessary to perform all Cx activities.

B. Provide equipment manufacturer's factory representative(s) for commissioning of classrooms lighting and its control system as required by the Cx Plan.

C. Provide certified testing agency personnel and/or report(s) as required in the Cx Plan.

3.3 TESTING

A. Testing documentation shall include the following minimum information:

1. Test number.
2. Equipment used for the test, with manufacturer and model number and date of last calibration.
3. Date and time of the test.
4. Indication of whether the record is the first commissioning test or a retest following correction of a previously identified problem or issue.
5. Identification of the system, subsystem, assembly, or equipment.
6. Conditions under which the test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of the test.
7. Systems and assemblies test results, performance and compliance with contract requirements.
8. Issue number, if any, generated as the result of the test.
9. Name and signature(s) of witnesses and the person(s) performing the test.

B. Test lighting and controls systems performance to verify operation, functionality, light levels, energy usage, and compliance with construction documents.

1. Contractor shall start up, test and document results under the observation of the CxA.
2. Contractor shall execute the Functional Performance Test (FPT) under the observation of the CxA who will record the results of the Functional Performance Test procedures.
3. Equipment & Components to be tested: Refer to Article 3.01, B.
4. Functions and Testing Conditions:
   a. Occupancy sensors and timer controls for lighting:
      1) Verify that all specified functions and features are set up, debugged and fully operable at time of test.

2) Verify that occupant override feature functions properly and as intended in the contract documents.

3) Verify that sensor durations are set properly.

4) Test the sequence of operation for all features and modes and confirm that adjustable timing matches the design specifications and contract documents.

b. Electric lighting dimming, photocells and controls:

1) Test the dimming controls during daytime when conditions are such that controls should be dimming electric lighting. Verify that amperage changes in light fixtures are proportional to external light changes. Verify that dimmed light levels at the specified work plane remain within specified limits.

2) Verify that delays and ramp times are set and functioning so that the speed of change of light fixture output is slow enough to not bother occupants and in compliance with the specifications.

3) Verify that dimming does not cause lower than specified light levels in adjacent “non-dimmed” spaces.

4) Verify that the controls and sensors cannot be easily overridden or disabled by occupants.

5) Verify that dimming systems in places of assembly are interfaced with the Central Fire Alarm system. Dimmed lighting in these areas shall come back to full bright during a fire alarm condition.

c. Illumination Levels, Night Conditions:

1) Verify that lighting throughout the building is operating automatically.

2) Test with doors closed (to simulate actual occupancy) and after finishes are complete.

d. Illumination Levels, Day Conditions:

1) Verify that lighting throughout the building is operating automatically.

2) Test with doors closed (to simulate actual occupancy), after finishes are complete, and room is furnished.

3) Test at different times during the day, or under Owner-approved simulated conditions, to ensure proper system response and to determine that lighting levels are within specified requirements.

4) Test the system for the different pre-determined settings. AV mode, and normal standard class operation.

e. Lighting Power Density: Perform the test with all interior lighting turned on and any manual or automatic controls temporarily overridden. The lighting power shall be measured at the building's electrical panels. Measurements shall be taken at least one (1) minute after all lighting in the building is on.

f. Emergency Lighting System: Verify that the system operates automatically under any condition, without human intervention, and that it resets back to normal operations after the power failure is over or cleared.

5. Acceptance Criteria:

a. Lighting Controls: For the conditions, sequences and modes tested, the dimming/occupancy/photocell/timing controls, integral components and related equipment respond to changing conditions and parameters appropriately as defined in the Contract Documents.

b. Illumination Levels: Average light levels in the tested space at the work plane elevation shall not be less than 10% below nor greater than 20% above the specified light level range for the space.

c. Lighting Power Density: Average instantaneous lighting power density is +/- 10% of that indicated in the Construction Documents. Power factors on lighting circuits shall be 0.95, or as required by lighting fixture specifications.

6. Sampling Strategy for Identical Units:

a. Lighting Controls: Test all automatic interior lighting controls.

b. Illumination Levels: At least 50% of all space zones and rooms, chosen by the Owner, shall be verified as realizing proper light levels. If 25% of the spaces in the first sample fail the Functional Performance Tests, test another 10% of the untested space zones and rooms (the 2nd sample). If 10% of the spaces in the 2nd sample fail, test all remaining spaces.

c. Power Density: Test all lighting circuits.

C. Contractor shall participate and perform all Cx related testing requirements prescribed under Sections 019100 and the approved project Cx Plan.

3.4 ADJUSTING

A. Systems improperly adjusted, incorrectly installed equipment and/or deficient Contractor performance may result in additional work being required for Cx acceptance.

1. Contractor shall perform all work required to correct installations not meeting contract requirements at no additional cost to the Owner.

B. Corrective work shall be completed in a timely manner to permit completion of the Cx process.

1. Contractor shall refer to the Cx Plan for retesting requirements necessary to achieve required system performance.
2. If the systems' Cx deadline, as defined in the Cx Plan, goes beyond the scheduled completion of Commissioning without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem.

END OF SECTION

SECTION 26 08 00

ELECTRICAL LIGHTING SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.7 SECTION INCLUDES

B. Section Includes:

1. General requirements for Commissioning (Cx) of lighting systems components and lighting controls including installation, start-up, testing and documentation according to Construction Documents and Commissioning Plan (CxP).
2. Standard procedures for the execution of commissioning work shall be in conformance with Division 1, Section 01 91 00 General Commissioning Requirements. Coordinate all work with the Commissioning Agent (CxA).

1.8 RELATED SECTIONS:

9. Provisions of Division 01 apply to this section.
10. Section 01 91 00: Commissioning.
11. Section 01 78 23: Operations and Maintenance Data Training.
12. Section 26 05 00: Common Work Results for Electrical.
13. Section 26 05 01: Electrical General Provisions.
14. Section 26 09 23: Lighting Control Systems.
15. Section 26 50 00: Lighting Fixtures.
16. Project Commissioning Plan.

1.9 REFERENCES

A. Applicable codes, standards, and references: all inspections and tests shall be in accordance with the following applicable codes and standards, except as provided otherwise herein:

14. National Electrical Testing Association – NETA.
15. National Electrical manufacturer's Association – NEMA.

16. American Society for Testing and Materials – ASTM.
17. Institute of Electrical and Electronic Engineers – IEEE.
18. American National Standards Institute – ANSI.
19. National Electrical Safety Code – NESC.
20. California Building Code – CBC.
21. California Electrical Code – CEC.
22. Occupational Safety and Health Administration – OSHA.
23. National Institute of Standards and Technology – NIST.
24. ANSI/NFPA 70 – National Electrical Code.
25. NFPA 70E – Electrical Safety Requirements for Employee Work Places.
26. ANSI/NFPA 101– Life Safety Code.

1.10 SUBMITTALS

B. Submittals shall include the following:

7. Submit required Cx submittals in accordance with Division 1 Specification Sections.
8. Copy of the Architect's reviewed and accepted submittals to the CxA via the OAR.
9. List of team members who will represent the Contractor in the Pre-functional Equipment Checks and Functional Performance Testing, at least two (2) weeks prior to the start of Pre-functional Equipment Checks.
10. Detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, checklist documentation and field checklist forms to be used by factory or field technicians, and a copy of full details of Owner-contracted tests, full factory testing reports, if any, and Warranty information, including responsibilities of Owner to keep Warranty in force, clearly defined.
11. Detailed manufacturer's recommended procedures and schedules for Pre-functional Equipment Checks, supplemented by Contractor's specific procedures, and Pre-functional Tests, at least four (4) weeks prior to the start of Pre-functional Performance Tests.
12. After facility's commission is complete, submit all completed Pre-functional Equipment Checklists and Functional Performance Test checklists organized by system and by subsystem. Bind all information in a single package. The results of failed tests shall be included along with a description of the corrective actions taken.

1.11 MEETINGS, SEQUENCING AND SCHEDULING

C. Meetings: Attend (Cx) meetings as required under Section 01 91 00 and the Cx Plan.

D. Sequencing and Scheduling: The work described in this Section shall begin only

after all work required in related Division 26 Sections has been successfully completed, and all tests, inspection reports and Operation & Maintenance manuals required in Division 26 Sections have been submitted and approved. The start-up and Pre-functional Equipment Checklists shall be completed and submitted to the Owner's Authorized Representative (OAR) prior to the Functional Performance Tests. Refer to the project Cx Plan for more details.

1. Coordinate all electrical work with the work of other trades prior to scheduling of any Cx procedures.
2. Coordinate the completion of all electrical testing, inspection, and calibration prior to start of Cx activities.
3. Cx activities shall be scheduled in accordance with project's Cx plan.

1.12 QUALITY CONTROL

B. Incorporate manufacturer's recommended Cx procedures for the systems and equipment to be commissioned under this Section.

PART 2 - PRODUCTS

2.2 TEST EQUIPMENT

A. Equipment to be utilized in the commissioning process shall meet the following requirements:

1. Provide test equipment as necessary for the equipment and systems to be commissioned.
2. Provide testing equipment and accessories that are free of defects and certified for use.
3. Provide testing equipment with current calibration labels per NIST Standards.
4. All testing equipment shall be UL Listed.

PART 3 – EXECUTION

3.5 COMMISSIONING PROCESS REQUIREMENTS

D. Work to be performed prior to commissioning:

3. Complete all phases of the work so the system(s) can be started, tested, adjusted, balanced, and otherwise commissioned.
4. If modifications or corrections to the installed systems are required to bring the system(s) to acceptance levels due to Contractor's incorrect installation or defective materials, such modifications or corrections shall be made at no additional cost to the Owner.

E. Pre-commissioning Responsibilities: Inspection, calibration and testing of the equipment and apparatuses to commission the following systems:

3. Electrical Lighting Systems.

4. Lighting Controls.

F. Commissioning Process Requirements:

1. Refer to Section 019100 General Commissioning Requirements, related sections and Cx Plan for information on meetings, start-up plans, Pre-Functional and Functional Performance Testing (FPT), operations & maintenance data, and other Commissioning activities.

3.6 PREPARATION

D. Provide certified electricians or other qualified personnel as required with tools and equipment necessary to perform all Cx activities.

E. Provide equipment manufacturer's factory representative(s) for commissioning of classrooms lighting and its control system as required by the Cx Plan.

F. Provide certified testing agency personnel and/or report(s) as required in the Cx Plan.

3.7 TESTING

D. Testing documentation shall include the following minimum information:

1. Test number.

2. Equipment used for the test, with manufacturer and model number and date of last calibration.

3. Date and time of the test.

4. Indication of whether the record is the first commissioning test or a retest following correction of a previously identified problem or issue.

5. Identification of the system, subsystem, assembly, or equipment.

6. Conditions under which the test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of the test.

7. Systems and assemblies test results, performance and compliance with contract requirements.

8. Issue number, if any, generated as the result of the test.

9. Name and signature(s) of witnesses and the person(s) performing the test.

E. Test lighting and controls systems performance to verify operation, functionality, light levels, energy usage, and compliance with construction documents.

7. Contractor shall start up, test and document results under the observation of the CxA.

8. Contractor shall execute the Functional Performance Test (FPT) under the observation of the CxA who will record the results of the Functional Performance Test procedures.

9. Equipment & Components to be tested: Refer to Article 3.01, B.

10. Functions and Testing Conditions:

g. Occupancy sensors and timer controls for lighting:

1) Verify that all specified functions and features are set up, debugged and fully operable at time of test.

2) Verify that occupant override feature functions properly and as intended in the contract documents.

3) Verify that sensor durations are set properly.

4) Test the sequence of operation for all features and modes and confirm that adjustable timing matches the design specifications and contract documents.

h. Electric lighting dimming, photocells and controls:

1) Test the dimming controls during daytime when conditions are such that controls should be dimming electric lighting. Verify that amperage changes in light fixtures are proportional to external light changes. Verify that dimmed light levels at the specified work plane remain within specified limits.

2) Verify that delays and ramp times are set and functioning so that the speed of change of light fixture output is slow enough to not bother occupants and in compliance with the specifications.

3) Verify that dimming does not cause lower than specified light levels in adjacent “non-dimmed” spaces.

4) Verify that the controls and sensors cannot be easily overridden or disabled by occupants.

5) Verify that dimming systems in places of assembly are interfaced with the Central Fire Alarm system. Dimmed lighting in these areas shall come back to full bright during a fire alarm condition.

i. Illumination Levels, Night Conditions:

1) Verify that lighting throughout the building is operating automatically.

2) Test with doors closed (to simulate actual occupancy) and after finishes are complete.

j. Illumination Levels, Day Conditions:

1) Verify that lighting throughout the building is operating automatically.

2) Test with doors closed (to simulate actual occupancy), after finishes are complete, and room is furnished.

3) Test at different times during the day, or under Owner-approved simulated conditions, to ensure proper system response and to determine that lighting levels are within specified requirements.

4) Test the system for the different pre-determined settings. AV mode, and normal standard class operation.

k. Lighting Power Density: Perform the test with all interior lighting turned on and any manual or automatic controls temporarily overridden. The lighting power shall be measured at the building's electrical panels. Measurements shall be taken at least one (1) minute after all lighting in the building is on.

l. Emergency Lighting System: Verify that the system operates automatically under any condition, without human intervention, and that it resets back to normal operations after the power failure is over or cleared.

11. Acceptance Criteria:

d. Lighting Controls: For the conditions, sequences and modes tested, the dimming/occupancy/photocell/timing controls, integral components and related equipment respond to changing conditions and parameters appropriately as defined in the Contract Documents.

e. Illumination Levels: Average light levels in the tested space at the work plane elevation shall not be less than 10% below nor greater than 20% above the specified light level range for the space.

f. Lighting Power Density: Average instantaneous lighting power density is +/- 10% of that indicated in the Construction Documents. Power factors on lighting circuits shall be 0.95, or as required by lighting fixture specifications.

12. Sampling Strategy for Identical Units:

d. Lighting Controls: Test all automatic interior lighting controls.

e. Illumination Levels: At least 50% of all space zones and rooms, chosen by the Owner, shall be verified as realizing proper light levels. If 25% of the spaces in the first sample fail the Functional Performance Tests, test another 10% of the untested space zones and rooms (the 2nd sample). If 10% of the spaces in the 2nd sample fail, test all remaining spaces.

f. Power Density: Test all lighting circuits.

F. Contractor shall participate and perform all Cx related testing requirements prescribed under Sections 019100 and the approved project Cx Plan.

3.8 ADJUSTING

A. Systems improperly adjusted, incorrectly installed equipment and/or deficient Contractor performance may result in additional work being required for Cx acceptance.

1. Contractor shall perform all work required to correct installations not meeting contract requirements at no additional cost to the Owner.

B. Corrective work shall be completed in a timely manner to permit completion of the Cx process.

1. Contractor shall refer to the Cx Plan for retesting requirements necessary to achieve required system performance.

2. If the systems' Cx deadline, as defined in the Cx Plan, goes beyond the scheduled completion of Commissioning without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem.

END OF SECTION

SECTION 26 09 23
OCCUPANCY MOTION SENSORS

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment 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 specification sections and drawings for related work required to be included as work under Division 26.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit data sheets on sensors, wiring diagrams, relays, transformers, junction and outlet boxes, and mounting accessories. Submit wiring diagrams. Submit agency certifications /approvals.

B. Submit details of pendant-mounted sensor installation.

1.03 APPLICABLE STANDARDS (ADDITIONAL REQUIREMENTS)

A. General
   1. All ultrasonic sensors shall comply with the State of California Safety and Health Requirements. Decibel levels for ultrasonic sensors shall comply with the following criteria and the State of California Energy Commission for ultrasonic emissions:

MAXIMUM DECIBEL LEVELS FOR ULTRASONIC EMISSIONS

Midfrequency of Sound Pressure Third-Octave Bank (kHz)	Minimum dB Level Within Third Octave Band (in dB reference 20 micropascals)
Less than 20	80
20 or more to less than 25	105
25 or more to less than 31.5	110
31.5 or more	115

   2. The CONTRACTOR and manufacturer shall certify in writing that all proposed and installed occupancy motion sensors comply with the Federal Environmental Protection Agency (EPA) and State of California Energy Commission criteria.
   3. Occupancy motion sensors shall be:
      a. UL listed and labeled.
      b. Certified for compliance with Federal-EPA and State of California Title-24 Energy Commission Requirements.

PART 2 - PRODUCTS

2.01 MOTION SENSORS

A. General
   1. Motion sensors and power supply shall be self-contained. The motion sensors shall be solid state low voltage devices designed specifically for energy conservation lighting control. Combined dual function ultrasonic and infrared motion sensing.
      a. Ultrasonic crystal controlled to within +/- 0.01% motion sensor technology.
      b. Passive infrared (PIR) motion sensor technology.
   2. Occupancy motion sensor shall also include available ambient light sensor, in addition to the motion sensor. The ambient light sensor shall prevent the occupancy motion sensor from automatically turning “on” the respective lighting when the ambient day-lighting intensity detected by photoelectric cell contained in the motion sensor exceeds a selected

intensity. The ambient light sensor circuit shall not control the automatic off function. The ambient lighting intensity detection sensitivity shall be adjustable in the sensor, adjustment range not less than 15 through 140 ambient day-lighting footcandles.

3. Automatic-off: sensor shall automatically turn "off" lighting when there is no movement after the preset time delay interval. Lights shall remain "on" with movement. There shall be a "dead band" time period after the unit turns itself off (because of lack of motion) during which a new motion will automatically turn lights on without the manual switch having to be activated.
4. Automatic-on: Sensor shall automatically turn “on” lighting when movement is detected in the monitored space. Lights shall remain on with movement. An internal control shall provide a mechanism to bypass the automatic-on control feature and allow only automatic-off functions. Where manual on/off [dimming] lighting control switches are shown on the drawings, in addition to the occupancy motion sensors in the same space, the manual controls shall override the automatic "on" control feature of the occupancy motion sensor. Override of the automatic "off" feature shall not be affected by the respective manual switches.
5. Motion detection sensitivity, time delays to turn "ON" after activation and time delays to turn "OFF, shall be adjustable to ensure there will be no nuisance on/off switching of the lights by the motion sensor while the room is occupied. Adjustable settings shall be tamper resistant, concealed behind an access protection cover.
   a. Fluorescent light fixtures with Instant Start or Rapid Start lamp ballast, set the minimum lamp "on" time at not less than 15-minutes. Program Start lamp ballast, set the minimum lamp "on" time at not less than 5-minutes.
6. Automatic self-adjusting Adaptive-Learning for time delay and sensitivity variable conditions in the monitored space.
7. Fail-to-on, the failure of a sensor shall cause the occupancy motion sensor load relay contacts to activate, so the occupancy motion sensor function is automatically bypassed and lighting is turned-on.
8. All occupancy motion sensors shall be provided with an indicator light to display when motion is being detected and the unit is operating correctly.
9. Non-volatile internal memory shall store and maintain in memory all occupancy motion sensor settings during any electric power failure.
10. Where multiple occupancy motion sensors are installed with overlapping monitoring spaces, the sensors shall not cause false triggering or malfunctions to adjacent occupancy motion sensors.
11. Occupancy motion sensors shall incorporate mechanical vibration-damping. The vibration-damping shall prevent normal building vibrations from causing “false” sensor operation.
12. As manufactured by WattStopper; or Leviton; or Hubbell; or Greargate.

B. Area Control Coverage
   1. Space coverage of motion sensor transponder shall remain constant after sensitivity control has been set. No automatic reduction/increase in coverage nor sensitivity shall occur when air motion caused by air conditioning or heating fans are in operation nor when the occupancy motion sensor has turned off lighting due to not detecting any motion.
   2. Occupancy motion sensors in spaces 300 square feet area or less may be a wall switch mounted unit.
      a. Wall switch sensors shall provide detection of motion at desk top, for up to 300 square feet,
         180-degree range within a volume dimension of up to approximately 20-feet by 15-feet by 10-feet high, extending from the wall mounting height of the unit to the finish floor.
      b. Wall switch occupancy motion sensors shall be a minimum load capacity of 500 watts 120V; 1000 watts 277V, but in no case shall the load rating be less than the lighting loads shown on the drawings.

3. Motion sensors in spaces exceeding 300 square feet in size and where shown on the drawing as mounted on the ceiling, shall be ceiling mounted. The sensor shall not protrude more than 1.6-inches below the ceiling line.
   a. Sensor area coverage shall be 360 degrees three (3) dimensional diameter surrounding the sensor installation location.
   b. The sensor shall be rated to provide coverage of the space volume/room length/width/ height shown in the contract documents. Provide additional ceiling mounted motion sensors to provide complete coverage of each area.
   c. Corridor/hallway sensor area coverage shall not be less than 80-feet linear feet extending from the sensor installation location. Sensor shall be bi-directional or uni-directional to provide complete area motion detection at the installation location shown on the drawings.

2.02 CONTROL UNITS

A. General
   1. Control unit shall be an integrated, self-contained unit consisting internally of load switching control relay(s); internal power supply and power supply transformer. The power supply shall be sufficient capacity to provide low-voltage power to a minimum of two (2) motion sensors.
   2. Occupancy motion sensors directly controlling line voltage electrical loads, the line voltage load relay contacts shall be “dry” type electrically isolated, with load ratings as follows:
      a. 15A – 120 volt single phase 60Hz AC.
      b. 15A – 277 volt single phase 60Hz AC.
   3. Load relay contacts shall be rated to control load types up to the full ampere rating. Incandescent Tungsten lamps for lighting equipment. Rapid start and instant start and Program Start solid state electronic ballast (both low power factor and high power factor) for lighting equipment.
   4. The quantity of individual internal load switching relays shall be not less than the quantity of individual “switchleg” circuits to be controlled shown on the drawings.

B. Occupancy Management control/Building Automation
   1. Provide each occupancy motion sensor control unit with auxiliary dedicated single pole double throw relay contacts operated by the motion sensors that shall be interfaced with building Energy Management Control/Building Automation (EMCS/BAS) energy management and/or building security systems. Relay contacts serving security function shall activate when motion is detected, regardless of whether the respective room manual light switches are on or off.

C. Occupancy motion sensors that connect to low voltage remote control relays (LVRCR) systems.
   1. LVRCR systems and occupancy motion sensor shall be rated and certified by the occupancy sensor manufacturer and the LVRCR manufacturer for proper operation with the LVRCR control port inputs and the occupancy motion sensor control output interface relay contacts. Occupancy sensor normally open, normally closed, maintained control relay contact, momentary control relay contact, control operation sequences in coordination with the LVRCR requirements for automatic “on and off” load control by the LVRCR.
   2. The occupancy motion sensor power supply input, voltage rating and current rating control interface should comply with LVRCR requirements.

2.03 OCCUPANCY MOTION SENSOR HOUSING ENCLOSURE

A. General
   1. Enclosures for occupancy motion sensor control units shall be pressed steel or high impact resistant nonflammable non-metallic enclosure. Enclosure finish color white. Semi-flush mounting installation, NEMA I “dead front” construction with mounting plates and barriers to provide separation between line voltage and low voltage wiring.

B. Mounting
   1. Flush mounting 4.67-inches square by 2.125-inches deep outlet junction box with extension ring and occupancy motion sensor cover mounting plate.
   2. Occupancy sensor shall be semi-flush mount into outlet box with tamper resistant attachment of the sensor and the outlet box.
   3. Motion sensor shall be approved for installation in environmental air plenum.

PART 3 – EXECUTION

3.01 MOTION SENSOR QUANTITIES AND TYPES

A. General
   1. The CONTRACTOR shall provide the quantity and types of motion sensors required for complete and proper volumetric coverage without gaps within the range of coverage(s) of controlled areas.
   2. Rooms shall be 90% to 100% volumetric coverage of the sensing coverage area, to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). Motion sensing detection coverage shall extend from the finish floor to not less than 48-inches above finish floor.
   3. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only rooms, which are to be provided with sensors. The CONTRACTOR shall provide additional sensors if required to properly cover the respective rooms.
   4. Ceiling mounted sensors shall also be pendant-mounted in rooms in which the controlled lighting fixtures are chain, cable or pendant suspension mounted. The mounting height of the sensor shall be approximately 6-inches below the bottom of the light fixtures to be controlled.
   5. Wall mounted sensors shall be installed at a height not higher than the bottom of the respective ceiling lighting fixtures. For Wall switches with integrated manual switch for “on” or “off” applications, mounting height shall not exceed 42-inches above finish floor.
   6. Occupancy sensors may be affected by various conditions in the room. Make adjustments, change the location and/or type of occupancy motion sensor to obtain proper operation in each specific room location.
   7. Install occupancy motion sensors a minimum of 72-inches horizontal distance from environmental air supply/return registers, fans and moving objects.

3.02 SETUP AND TESTING

A. Commissioning (Additional Requirements)
   1. Setup, testing, startup and commissioning shall be performed by factory technician(s) trained, certified and authorized by the equipment manufacturer. Final commissioning shall be performed after installation and connections are complete.
   2. Provide system programming and setup of all control sequences for lighting control system.
   3. Adjust sensitively, time-delay, location and orientation of each occupancy motion sensor; test each sensor/control unit all in accordance with the manufacturers recommendations. Be certain that no obstructions block proper sensor coverage of detection areas and limit sensor pickup zone to the respective room.
   4. Test all control system functions after the installation and connections are complete and the system has been energized. Verify each control sequence of operation and each device to be controlled are operating correctly.
   5. Verify interconnections and controls with the:
      a. Lighting control systems.
      b. Security/intrusion detection systems.
      c. Building automation systems (BAS and energy management and control systems {EMCS).
   6. Record and document each sensor setup and program setting.

7. Submit written report (3 copies) to District's Representative certifying commissioning has been performed; all respective systems are operating correctly and documenting all software setup and each device settings.

3.03 WIRING (ADDITIONAL REQUIREMENTS).

A. General

1. The drawings do not indicate the quantity of control wires required between various control points. The CONTRACTOR shall provide the quantity and type of control wire required for proper system operation, as recommended by the system manufacturer. Install all control circuits in conduit.
2. Control wire shall be copper #18AWG minimum, twisted pairs, PVC insulated for control voltage, color coded to match relay and switch wiring "pigtail" color codes.
3. Network communications wires shall be ANSI/EIA/TIA-568B, 100-OHM, 4-pair shielded twisted pairs STP, Category-5E.
4. Where multiple control wires are installed in a signal conduit or route to a single location provide multiconductor control cables with outer jacket. Control wires for control of relay controllers which shall be separate twisted shielded four wire PVC insulated conductors, with a ground wire and outer jacket for each controller to prevent "RF" inference.
5. Control wire shall be increased in wire gauge size as required to ensure proper system operation and voltage drop over the installation distance shown on the drawings between equipment and control device locations.
6. Occupancy motions sensor control power shall be powered from line voltage "hot" non-switched, lighting branch circuit. Alternately, control power may be obtained directly from the respective lighting control panel (if available). Provide two additional #12 (AWG) "hot-circuit" and neutral unswitched conductor in conduit homeruns and branch circuits.
7. All wiring shall be installed in conduit.

END OF SECTION

SECTION 26 09 43

LIGHTING CONTROL SYSTEM

PART 1 -General

1.01 INTRODUCTION

A. The work covered in this section is subject to all of the requirements in the General Conditions of the specifications.

B. Contractor shall coordinate all of the work in this section with all the trades covered in the other sections of the specification to provide a complete and operative system.

1.02 DESCRIPTION OF WORK

A. Extent of lighting control system work is indicated by drawings, and by the requirements of this section. It is defined to include low voltage lighting control panels, switch inputs, and wiring.

Type of lighting control equipment and wiring specified in this section include the following:

Low Voltage Lighting Control Panels

Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.

1.03 QUALITY ASSURANCE

A. UL & ULc Approvals
The control panels shall be tested an'd listed under the UL 916 Energy Management Equipment standard and CSA C22.2 #205 by a nationally recognized testing laboratory.

B. NEC Compliance
The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.

C. NEMA Compliance
The control system shall comply with all applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.

D. Component Pre-testing
All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.

E. System Checkout
A factory trained technician or factory authorized personnel or contractor shall functionally test the control system and verify performance after installation.

F. Manufacturer
Manufacturer shall have a minimum of 20 years experience in control systems. Manufacturer shall provide off the shelf control products from its inventory. Control systems that require custom assembly and sizing shall not be acceptable. Manufacturer shall be Cooper Controls. Product shall be ControiKeeper® 4A control panels or approved equal by Lutron, LC&D.

1.04 SUBMITTALS

A. Product Data

Submit manufacturer's data on lighting control system and components.

B. Shop Drawings

Submit drawings of lighting control panels and accessories including, but not necessarily limited to the low voltage relay panels, power wiring, and switch inputs.

PART 2 – Products

2.01 MATERIALS AND COMPONENTS

A. SYSTEM DESCRIPTION

1. The lighting control system shall consist of stand alone programmable low voltage relay control panels with 64 programmable switch inputs and shall offer 4 ON/OFF control relays.
2. The lighting control system shall provide 4 analog outputs to control 0 – 10 VDC outputs for dimming control. The controller shall provide 4 analog inputs for adjustable analog photocell control.
3. Each low voltage lighting control panel shall be microprocessor controlled. Programming shall be accomplished through either the RS-232 port or through the network connection employing the Keeper Enterprise software.
4. Programmable intelligence shall include Time-Of-Day control, 32 holiday dates, warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control, digital switches and network overrides.

TOD	64 Time-Of-Day/holiday schedules for 365 day programming
Holidays	32 holiday dates
Warn Off	Flash lights and provide an extra 1 second to 99 minutes of illumination
Preset	Pre-programmed switch patterns
Timed Inputs	Switch input timers 1-999 minutes
Timed Overrides	Timed override 1-999 minutes, resumes to normal schedule
Local Control	From local switch
Astronomical Clock	Longitude and latitude input with sunset-sunrise offsets to customize outdoor lighting
Auto Daylight Savings Adjust	Automatically adjusts the clock at the appropriate dates, selectable
Priorities	Establishes a hierarchy for inputs and network control commands
Masking	Provides permission orientation to switch inputs and network commands thereby ensuring building lighting control integrity.
Soft-Linking	Group linking for rapid programming
Global Linking	Each panel shall provide 64 addressable groups for network linking of control commands

5. Relays within this control system are auto-configurable. The controller shall auto-sense the type of relay card and automatically configure the type of card to the controller's database. The controller shall inherently "know" what type and the electrical configuration of the relays. This shall be called the lntelliRelay design. Relays may be inverted to create custom control algorithms so the control system can be fine-tuned for the specific control application. Relay status shall not only disclose commanded relay status, but next scheduled state to occur.
6. Each control panel shall provide a Warn Off (flash the lights) to inform the occupants of an impending Off command. The Warn Off command shall provide an adjustable time duration of 1 second to 99 extra minutes. The occupants may exit the premises with adequate

lighting or cancel the Warn Off by overriding the lighting zone. This option occurs with all Off commands except local overrides.

7. The controller shall permit lighting to be overridden On for after hours use or cleaning. The controller shall provide optional switch timer assignments or timed overrides. The override choices for various relays shall provide special event occurrences and the controller shall return to the programmed state after the override event Also, the controller shall provide priority and masking choices to customize the functions of switch inputs, thereby enabling switches to function differently at different times of the day to meet special facility operational requirements. These overrides shall be digital, network, or hard-wired inputs.
8. Programming the controller shall be through the RS-232 port or through the network connection. Communication to the panel or network can be accomplished via, RS-232, RS-485, modem, or TCP/IP.
9. Priorities and/or Masking shall be assigned to inputs, telephone override, and global commands to insure building integrity. Priorities enable or disable the inputs based on user actuation of overrides. Masks shall permit: On only, Off only, Ignored, No Timer, Re evaluate Now, and On & Off control permissions for intelligentafter hours utilization of the controlled facility based on Time-Of-Day scheduling within each controller.
10. Control station inputs shall provide 8 fully programmable dry contact type inputs and 64 digital switch inputs per controller. Each button or switch input shall be configurable as described in the following table.
    a. Control Station Profiles: (each may be defined uniquely)
        1) A press on a button
        2) A hold on a button (of which three options are programmable) .5 sec, 2 sec & 5 sec (each time period may invoke a specialized command)
        3) A tapon a button
        4) A release definition for a button
        5) Ramp rate adjustments
11. The control system shall provide dimming profiles to account for the differences of lamp and ballast combinations. Profiles are permitted to be diverse and fully adjustable to accomplish the most appropriate control based on user acceptability. Each output shall permit a unique preset or fully configurable option per output. Output profiles shall also include: Minimum Off Level, Minimum & Maximum dimming levels.
    a. Dimming Output Execution: (dimming output commands)
        1) Ramp rate
        2) Ramp time
        3) Change by %
        4) Go to a level
        5) Hold
12. The control system shall provide fully configurable photocell control algorithms. Photocell control shall permit open loop control for daylight or outdoor applications. The controller shall also provide closed loop control for sophisticated indoor applications. Both control algorithms shall permit adjustments to the upper and lower thresholds. The Keeper Enterprise software shall permit the user to create custom control loops for each of the analog output dimming loops. The loops in each controller shall be available to be modified remotely via the programming software.
13. The control system shall provide networking between lighting control panels. One network may support a maximum of 254 control panels. Panels shall permit data sharing for global control. All inputs (no limitation) are transferable over the network to create any switching pattern required. The maximum length of the lighting control network shall be 4000 feet. Repeaters are available to extend the network as needed. Networks that rely on a single time clock for system operation shall not be acceptable.
14. The lighting control system shall be able to log all control events. The controller shall monitor all relay actuations, switch inputs and user intervention. Log reports shall be available for any duration of time the operator chooses through the Keeper Enterprise Software. Runtimes for each relay shall be available from the Keeper Enterprise Software.

15. The lighting control system shall permit LED annunciated digital switches. Each digital switch shall provide status feedback of any control relay in the entire lighting control network.

B. HARDWAREFEATURES

1. Diagnostic Aids

Each control panel shall incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids shall guide the individual in rapid troubleshooting of the system. a. The control panels shall employ LED's to indicate:

1) POWER (LED)
2) SYSTEM OK (LED)
3) NETWORK COMMUNICATIONS (LED)
4) ON/OFF STATUS of EACH RELAY (LED)
5) DIGITAL SWITCH NETWORK COMMUNICATION LED's- (TX & RX)

Control systems that do not provide visual self-help diagnostics shall not be acceptable.

b. Status Indication of Relays

The system shall provide visible status indication of all relays. The visual indication shall disclose On/Off status and relay number. Systems that do not provide relay status shall not be acceptable.

2. Operator Interface

The control panel programming interface resides in firmware in the control panel. The programming interface shall consist of external software that provides access to all the controller's features. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted. Systems that utilize blocking diode technology for relay assignments shall not be acceptable.

3. Overrides

The controller shall provide timers for each override. Each override timer shall be capable of 0-999 minutes. Software shall enable or disable overrides based on Priorities, Masks or Time Of Day scheduling.

a. Digital Switch (DigitaTM)

The lighting controller shall support digitally addressable LED annunciated switches. The maximum total number of digital switches that may exist on the lighting control network is 16,256. Each Subnet shall support 64 buttons. The digital switch network requires CAT 5 cable between switches. The digital switches shall control any relay group combination on the lighting control network. Data communications status feedback for system checkout and troubleshooting (transmit and receive LED'S) shall be visible on both the controller and interface.

The digital switch configuration system shall permit custom labeling for multiple button switch locations. The digital switch configuration shall be Decora® form and function.

b. Dry Contact Inputs

The control system shall permit 8 dry contacts inputs for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Maintained contacts shall be supported as 2 wire (SPST) inputs. Inputs shall be dry contacts (24 VDC @ 12 rna. internally supplied to the inputs). The 24 VDC power supply is provided with an auto-resettable fuse. Should an inappropriate electrical connection be made the design will protect the board and switches until the fault is removed. Any switch input shall be software linked to any number of relays for override control. The control panel shall have dry contact inputs on the logic board. Control systems that utilize separate accessories to allow for dry contact switches shall not be acceptable. Control systems that do not supply both digital switches and analog switches from the same controller shall not be permitted.

c. PhotoceiiControl

The controller shall accept either dry contact or analog ambient light sensors. The

controller shall provide power for the sensor thereby eliminating any external power supply. Sensors shall provide for outdoor, indoor or skylight applications and issue a command to the controller once the threshold is reached. The sensor shall provide either software or user adjustable dead band control. Photocells shall be 0-10 VDC type and available in ranges based on the application for best granularity of control.

d. Network Overrides
The controller shall accept network commands issued from other inputs or controllers on the network. The controller shall provide this feature without the need to add extra equipment to the controller. Network overrides can be issued from the Telephone Interface Module (TIM), Modbus® Gateway, DMX Gateway, Photocells, Motion Sensors, Digital or Dry Contact Switches, or other controllers. Lighting systems that need to add extra equipment to receive network overrides are not acceptable.

4. Service Override & Priority Override
The control panel shall provide a three position master-service override for the control unit. The service override shall not be accessible from the exterior. Systems that provide a service override on the exterior of the controller shall not be acceptable.
The master service override provides a single three-position switch with the option of All Off, Auto, and All On, respectively. This master switch shall operate all of the relays in the controller. This switch shall override and supersede all commands from the logic board when the switch is in the All On or All Off position. The master switch shall function to override all the relays should the logic board programming differ from the space function.
The system shall report all master service overrides to the controller and shall be accessible via network query. Systems that cannot determine when the service override is in use shall not be acceptable.
The system shall remember the last command to the individual relays. Upon returning the master override switch to the Auto position, the relays shall return to the most recent command state. This will occur even if the last command happened during the master override condition.

5. Relays
The controller shall come standard with 4-20amp 120/277VAC electrically held relays. The wire terminations shall be able to accept 10 AWG. relays. Select from the Relay Output Options which additional relays will be utilized in the ControiKeeper® 4A controller for your application.

a. Serial Standard Relay Card (sSRC-NO)
The system shall utilize normally open control relays, which are rated to 20 amps at 120/277 VAC. The relays shall be magnetically held and are provided in-groups of four relays per card. Each relay card shall permit individual override and LED confirmation of relay state. The relays shall be rated for 10 million mechanical operations. The wire terminations shall be able to accept 10 AWG. A limited 10-year warranty shall be provided on the individual relay cards. Systems that do not offer a limited 10-year warranty on all installations are not acceptable.

b. Serial Standard Relay Card (sSRC-NC)
The system shall utilize normally closed control relays, which are rated to 20 amps at 120/277 VAC. The relays shall be magnetically held and are provided in-groups of four relays per card. Each relay card shall permit individual override and LED confirmation of relay state. The relays shall be rated for 10 million mechanical operations. The wire terminations shall be able to accept 10 AWG. A limited 10-year warranty shall be provided on the individual relay cards. Systems that do not offer a limited 10-year warranty on all installations are not acceptable.

c. Serial Two Pole Relay Card (sTPRC-NO/NC)
The controller shall provide an option for two-pole relay control. The Two Pole Relay Card shall offer the feature of controlling two pole voltages such as 208, 240, and 480VAC in a Normally Open or Normally Closed configuration. This relay card shall also provide visual indication of relay status. The wire terminations shall be able to accept 6 AWG wire. Two pole modules require two relay locations for a maximum of

two-two pole relays per card. All Two Pole Relay Module components shall be warranted for 10 years. Systems that do not offer a limited 1a-year warranty on all installations are not acceptable.

d. Serial Latching Relay Card (sLRC)
The controller shall provide an option to provide latching relays that are rated to 20 amps at 347 VAC. The relay shall provide an integral switch for both manual hand operation and visual indication of relay status. The relays shall be rated for 10 million mechanical operations. The wire terminations shall be able to accept 6 AWG wire. A limited 10-year warranty shall be provided on the individual relays. Systems that do not offer a limited 1a-year warranty on all installations are not acceptable.

6. RS-232 port
The controller shall provide an RJ-12 connection for RS-232 communications. Programming shall be permitted through either a local connection or remotely through a modem. The Keeper Enterprise software accessory includes a six wire communication cable to connect to the controller. Systems that do not include an on-board RS-232 port at each controller location for communications are not acceptable.

7. RS-485 Network
The controller shall be able to communicate to other controllers on a daisy chain twisted pair of wires. The RS-485 network shall support 254 controllers with a maximum distance of 4000 feet. Each controller shall be optically isolated on the network. The networked controllers shall provide optical isolation between controller power supplies for true electrical isolation (communication grounds are 1aa% isolated). CAT-5 or Belden #9841 shall be approved for network wiring.

8. Modular Design
The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on standoffs for quick field replacement. All connections for the switch inputs shall incorporate modular connectors. Systems that do not employ modular connectors shall not be acceptable.

9. Memory Back-up
The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable.
The data in RAM shall be protected against power interruptions lasting as long as 7 days. The power interrupt protection circuit shall be entirely maintenance-free.

1a. Multi-tapped Transformer
The control panel employs a voltage specific transformer. The panel provides both 12a and 277 VAC for each controller location.

11. Enclosure
Each control panel shall be enclosed in a NEMA class 1 enclosure. The low voltage controller shall exist in one size enclosure (10"H x 14"W x 3.5"D) with 4 relays per cabinet. The enclosure provides a locked open feature for ease of installation and future access for control confirmation.

12. Keeper Enterprise Software
The PC based interface software accessory provides access to lighting control system files within a Microsoft® Windows® environment. The Keeper Enterprise software shall support Windows® 2000, Windows® XP and above. The optional software package shall allow individual and network panel programming to be executed locally, via direct connection or remotely through a TCP/IP connection or modem. The central programming software shall permit the user to modify the control panel programming or configuration in an "OFF-LINE" mode. This software package shall store all programmed data and archive for future use. Systems using third party software are not acceptable. Systems that are not capable of creating program backups are not acceptable.

13. The following features shall be standard in the PC based software:
    a. Standard Software Features:
        • Real Time Relay Status Monitoring
        • Alpha-Numeric Descriptors

- Communications: Direct, Network, TCPIIP and Modem
- Network Status Indication
- Global Software Modifications
- Manual Relay Commands
- Remote Pattern Commands
- Preset Options
- User Management- Password protection, and privilege modification for multi-user security
- Logging of Controller Actions (switch inputs, TIM commands, & relay actuations)
- Remote Commander -(entire network global commands from one screen)
- Runtime of each controlled circuit in hours.

b. File Maintenance
Archive Programs
Data Base Restoration
Uploading and Downloading of Programs
Snap Shots — indication of changes and flawless panel restoration

Software package shall permit the PC to be utilized for other functions (i.e. word processing, database, and etc..) besides lighting control. Systems that require an "on-line" dedicated computer for control system operation shall not be acceptable.

14. System Management Software Accessories require the Ethernet Interface Module (EIM) accessory, connection to the building LAN and Windows® 2000, Windows® XP or above operating system.
    a. VisionTouch®
    The lighting zones may be controlled through a graphical representation software package called VisionTouch®. The software permits up to 255 floors or site plans to be illustrated for intuitive control. The software provides real-time feedback to the operator of network control overrides. The software shall be accessible through an Ethernet network permitting more than one location control access to the site. The software shall accept AutoCAD® drawing files to reduce programming set up of the control software.
    b. VisionSwitch®
    A lighting control tool which, when integrated on a computer desktop, shall employ Ethernet communications and shall control up to four load-groups per computer desktop. Each load-group shall span several panels and relays. VisionSwitch® requires the Cooper Controls Ethernet Interface Module.
15. Network Hardware Accessories
    The ControiKeeper® 4A has several hardware accessories that may be utilized to enhance your lighting control application. Select from the network hardware accessories which accessories will be utilized for your application.
    a. ControiKeeper®-TouchScreen (CK-T)
    The CK-T shall provide additional flexibility by providing up to 48 relays that are addressable and fully programmable from the network. The CK-T controllers although accessible through the network shall be fully stand-alone in their control capability. The controller (CK-T) provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide 32 dry contact inputs that may be configured as a maintained, or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK-T. Systems that utilize the master slave topology shall not be acceptable.
    b. ControiKeeper® 2 (CK 2)
    The CK 2 shall provide additional flexibility by providing two 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 2 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 2 provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide 2 dry contact inputs that may be configured as a

maintained, or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 2. Networks that rely on a single time clock for system operation shall not be acceptable.

c. ControlKeeper® 4 (CK 4)

The CK-4 shall provide additional flexibility by providing four normally open or normally closed 20 amp@ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK-4 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK-4 provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide 4 dry contact inputs that may be configured as a maintained, or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK-4. Networks that rely on a single time clock for system operation shall not be acceptable.

d. AnalogKeeper™ (AK)

Provides the ability to provide additional analog remote sensing to the Control-Keeper® network. An analog photo sensor connected to the Analog-Keeper™ shall broadcast photocell light levels/thresholds onto the ControiKeeper®'s network for any specific relay or group of relays to employ. The actual network broadcasted data shall be available for any relay to actuate either an "on/off' at any preset analog value for total global control. All relays connected to the network are capable of being set to different analog photo sensor values for total building control.

The AK shall permit custom sensors with varying sensing ranges for more user choices. The AK shall also supply adjustable Minimum ON's, OFF's and Maximum OFF's. The AK shall provide analog sensor logging so information may be recorded for proper switching control choices.

e. Ethernet Interface Module (EIM)

Internet Connection Specifications: The control system accessory provides easy access to control panels over a TCP/IP connection by converting sent information into RS-232 communication capable information. This unit operates on standard 11OVAC. Manufacturer shall provide proper cabling from controller to Ethernet Interface Modules. RJ-45 connections are the responsibilities of others.

This specification will outline the respective responsibilities of lighting control systems manufacturer and of the customer when a TCP/IP connection is used for communication to the Lighting control systems manufacturer network.

1) Lighting Control Systems Manufacturer's Responsibility to the Customer

Lighting control systems manufacturer will supply one Ethernet Interface Module per network when a TCP/IP connection is used.

Instructions on how to install and configure the Ethernet Interface Module shall be supplied by Lighting control systems manufacturer.

2) Contractor's Responsibility

The Contractor will provide an IP address, Subnet Mask, Default Gateway, and a TCP Port Number for each Ethernet Interface Module required. The customer shall provide a qualified Network Administrator to properly configure the device(s). Any future changes to the customers TCP/IP network that affect the operation of the device(s) will be the customer's responsibility.

The Contractor will be responsible for any Internet and Virus Protection Security measures. This includes, but is not limited to, Firewall, Proxy Servers, and Virus Protection Software.

The Contractor will provide a qualified Technician to install and connect the Etherhet Interface Module to the building's LAN and to the lighting panel. The Ethernet wire should be Category 5 wire and installed per Category 5 wiring specifications.

VPN hardware device accessory: An optional VPN hardware device may be added to your lighting control network and building LAN to ensure security of your building LAN and lighting control network.

f. Telephone Interface Module (TIM}

The control system shall provide intelligent software for the Telephone Interface Module (TIM) option. The optional TIM unit shall allow modem communications and touch-tone overrides from any touch-tone phone. The control system shall be multi tasking and permit up to one TIM for each control panel.

Override Operation: Touch-tone interface shall permit the control panel to command pre-assigned control points On/Off. All user interfaces shall be through the twelve Touch-tone keys on the telephone. All entries into the override system shall be prompted by a digitized voice. Systems not employing voice guided override instruction are not acceptable.

The TIM shall provide individual control passwords. Each password shall allow a preset group designation (number of relays) and the duration of the telephone override. TIM shall also provide a password to prevent entry into the override control system.

g. Modem

The control system shall be capable of modem communications. Each control panel shall provide a serial communications port for external telecommunications. The modem shall utilize the Hayes compatibility standard and enable modem access as defined by the Beii212A and CCITT V.22 protocol standards.

The system shall be a multi-tasking system and permit more than one modem in operation at a time communicating on the network. Communication speed shall be a minimum of 14,400 baud.

h. Inter-Operability

The controller shall provide accessories that allow for inter-operability to other building automation technologies. Select the appropriate inter-operability accessory that will be utilized for your application.

1) MODBUS® Gateway

The ControiKeeper® network shall permit data protocol translation through a MODBUS® Gateway. The MODBUS® Gateway permits MODBUS® communication to operate individual relays, relay groups and read the status of the coils (status read}. The ControiKeeper® shall respond efficiently to the requested MODBUS® commands as a MODBUS® slave listening to commands from a MODBUS® master. The MODBUS® Gateway shall provide data messaging structure to rapidly increase data throughput by employing relay groups directly from the MODBUS® Gateway.

2) DMX Gateway

The ControiKeeper® network shall permit data protocol translation through a DMX Gateway. The DMX Gateway permits DMX communication to operate individual relays, and relay groups. The ControiKeeper® shall respond efficiently to the requested DMX commands. The DMX Gateway shall provide data messaging structure to rapidly increase data throughput by employing relay groups directly from the DMX Gateway.

3) N2 Gateway

The ControiKeeper® network shall permit data protocol translation through a building automation interface Gateway. The N2 Gateway shall permit Johnson N2 communication protocol to operate individual relays, relay groups and read the status of those relays. The ControiKeeper® network shall respond efficiently to the requested information from the Johnson Controls N2 network.

4) BACnet Gateway

The ControiKeeper® network shall permit data protocol translation through a building automation interface Gateway. The BACnet Gateway shall permit BACnet communication protocol to operate individual relays, relay groups and read the

status of those relays. The ControiKeeper® network shall respond efficiently to the requested information from the BACnet network.

5) LON Gateway
The ControiKeeper® network shall permit data protocol translation through a building automation interface Gateway. The LON Gateway shall permit LonWorks communication protocol to operate individual relays, relay groups and read the status of those relays. The ControiKeeper® network shall respond efficiently to the requested information from the LonWorks network.

C. ACCEPTABLE PRODUCTS

1. Product
ControiKeeper® lighting control unit manufactured by Cooper Controls, 6 Green Tree Drive, So. Burlington, VT 05403-6025

PART 3 – Execution

3.01 EQUIPMENT INSTALLATION AND DOCUMENTATION

A. Installation
The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits, and override wiring.

B. Documentation
The contractor shall provide accurate "as-built" drawings to the owner for correct programming and proper maintenance of the control system. The "as-builts" shall indicate the load controlled by each relay and the relay panel number.

C. Operation and Service Manuals

The factory shall supply all operation and service manuals.

3.02 PRODUCT SUPPORT AND SERVICE

A. Factory Support

Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

3.03 SYSTEM DELIVERY AND ACCEPTANCE

A. Delivery
The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements:

1. All system equipment shall operate in accordance with specification and industrial standard procedures.
2. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
3. Demonstration of program integrity during normal operation and pursuant to a power outage.
4. Contractor shall provide a minimum of two (2), two-hour training sessions on the operation and use of the control system - - one for on-site staff and FASO technicians BEFORE beneficial occupancy acceptance of the system; and one on-site exclusively for FASO technicians within the first week of occupancy. Each training shall be arranged with 48-hour advance notice and be held at a time arranged through the Project Manager.

   In addition, Contractor shall provide a minimum of two (2), one-hour, on-site programming assistance sessions at the request of the District FASO Supervisor during the 1-year Contractor warranty period.

3.04 WARRANTY

A. Warranty

Manufacturer shall supply a 3-year warranty on all hardware and software. A 10-year warranty is provided on the relay card module. These warranties will be in effect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

END OF
SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment 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 specification sections and drawings for related work required to be included as work under Division 26.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Provide schematic "ladder type" logic control wiring diagrams and "point-to-point control wiring diagrams showing control and protective systems interlocks.

B. Provide nameplate engraving schedule.

C. Submit full-scale time/current transparencies on log/log paper for all fuses, circuit breakers, ground fault system devices, and relays. Additionally, provide software to generate time/current curves of each circuit protection device.

D. SHORT CIRCUIT, COORDINATION AND ARC-FLASH
   1. Perform and submit engineered settings for each equipment location, fuse and circuit breaker device, showing the correct time and current settings to provide the selective coordination within the limits of the specified equipment, per the latest applicable standards of IEEE and ANSI. Provide electrical system short circuit fault analysis, both 3-phase line- to-line and 1-phase line-to-ground calculations as part of the coordination analysis recommendations. Provide Electric ARC-FLASH calculations as part of the coordination analysis recommendations.
   2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an engineering narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six (6) copies.
   3. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified contract equipment. Shall comply with, but not limited to:
      a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
      b. IEEE-399, Recommended Practice for Industrial and Commercial Power System Analysis.
      c. IEEE-1584, Guide to Performing ARC-FLASH Hazard Study.
      d. CEC/NEC
   4. 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.

E. Factory Tests: Equipment tests - ANSI C37.20. Certified copies of design tests, production tests, and conformance tests of the equipment shall be submitted and review comments shall

be received before delivery of equipment to the project site. In lieu of the above tests, a report of these tests previously performed on identical units of each rating will be acceptable.

1.03 APPLICABLE STANDARDS

A. The switchboard and switchgear equipment shall be designed, tested and assembled to comply with ANSI, IEEE, and NEMA and UL.

B. Seismic Earthquake and wind loading withstand, testing and certification (ADDITIONAL REQUIREMENTS).
   1. The complete switchboard/switchgear assembly; including circuit protection devices, meter, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested.
      a. Wind loading all outdoor equipment locations.
      b. Earthquake seismic requirements of CBC/IBC Seismic withstand all indoor and all outdoor equipment locations.
   2. Shall withstand, survive and maintain continuos non-interrupted energized operation during the seismic event occurrences and wind event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
   3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation. Acceptance test seismic qualification of proposed switchboard and/ or switchgear shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
   4. Provide three (3) dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading not less than as follows and as required by AHJ:
      a. 100MPH-West coast states USA, California, and Hawaii.
      b. 150MPH-East coast states USA, Gulf coast states USA and Alaska state.
      c. 90MPH-all other USA locations.
   5. Seismic test shall be performed by a third party independent test laboratory. Wind analysis and seismic Testing and reports shall be certified, signed and “stamped” by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.

C. Equipment components/devices, switchboards, and/or switchgear shall be manufactured by: General Electric; or Cutler-Hammer; or Square–D; or Siemens.

PART 2 - PRODUCTS

2.01 BUSSING

A. Horizontal and vertical busses shall be full lengths in each equipment section. Buses shall have a minimum short circuit fault withstand rating equal to available fault current indicated on drawings, plus a 25% additional capacity (safety margin). However, in no case shall the rating be less than 50,000 amperes, symmetrical.

B. Provide interconnected full capacity neutral bus in each section with the same ratings and construction as the phase busses.

C. Provide interconnected ground bus in each section.

D. Provide space and all hardware and mounting attachments for future devices as indicated on the drawings.

E. Main horizontal phase and neutral bussing shall be full capacity in all equipment sections. The through bus of the end distribution section shall be extended and pre-drilled to allow the addition of future sections.

F. Vertical riser buss may be tapered, to not less than one third the ampacity rating of the main horizontal buss; but in no case shall the vertical buss be of less capacity than the sum of the

frame size ampacities of overcurrent devices mounted in the respective sections including any indicated spares and spaces.

G. The equipment bussing shall be of sufficient cross-sectional area to meet UL Standard 891 on temperature rise Bus shall be copper with silver plated bus joints or extruded aluminum with tin plated bus joints. The through bus shall have provisions for the addition of future sections. The through bus supports, connections and joints are to be bolted with grade 5 hex head bolts and Belleville washers to minimize maintenance requirements.

2.02 CIRCUIT BREAKERS

A. General
   1. Circuit protective devices as indicated on the drawings. All devices shall have a short circuit interrupting capacity not less than the maximum available fault current at the circuit breaker and as indicated on the drawings, plus a 25% additional capacity (safety margin). However, in no case shall the circuit breaker interrupting capacity be less than 30,000 ampere symmetrical interrupting for 480/277 volt devices and 42,000 ampere symmetrical for 240 volt or 208/120 volt devices.
   2. Provide padlock-off devices on each device. Breakers shall provide automatic time over-current and instantaneous circuit protection. Shall be suitable for use as “Main” service disconnect, “Feeder” and “Branch-Circuit” functions.
   3. Circuit breakers shall employ a self-powered stored energy, quick make-quick break, and trip free operating system on each phase, with common trip. Circuit breakers shall not trip in the event of short term or long term electrical power failure. Dead front cover accessible close-open controls, monitors and visual indicator flags.
   4. Circuit breakers noted as "100%" on the drawings shall be tested and rated to carry the breaker full rated (100%) ampere load continuously including the assemblies the circuit breakers are installed into.
   5. Provide conductor lugs for circuit protection devices to accept conductor temperature rating, sizes and quantities shown on drawings. Circuit protection devices shall be UL-listed suitable for normal and reverse feed.
   6. Provide auxiliary contacts on circuit breakers. Auxiliary “DRY” contacts shall provide supervised remote monitoring of “Open-Close-Trip” circuit breaker status. Typical for circuit breakers supplying the following types of connected electrical loads.
      a. Fire alarm equipment and devices.
      b. Mass-evacuation equipment and devices.
      c. HVAC smoke control and smoke evacuation equipment.
      d. HVAC fire/smoke electrically operated dampers.
      e. Intrusion detection and access control equipment and devices.
      f. Elevators and escalators.
      g. Fire sprinkler pumps.
   7. Plug-in communications port for circuit breaker portable test instrument connects.
   8. Circuit breaker data monitoring and communications:
      a. The circuit protection devices shall monitor, communicate and report circuit voltage, ampere, power, and harmonic parameters for the respective connected circuit. The circuit protection device monitor and communication parameters shall be the same and compatible with the specified “METERING” devices.
      b. Additionally the circuit protection devices shall monitor and communicate the respective device status as follows:
         1) Open/close/trip device status
         2) Ground fault trip status (where applicable)
      c. Provide circuit breaker data monitoring and communications for each of the individual feeder protection devices and main protection devices located in switchgear and switchboards, rated 400 ampere or greater trip rating.

d. The respective “METER” display selection control functions shall provide selection and display of all information monitored and communicated by individual protection devices on the respective meter alphanumeric display.

9. Circuit breakers shall be Power Circuit Breaker type, Insulated Case Circuit Breaker type or Molded Case Circuit Breaker type. Time/current and instantaneous characteristics and selection of circuit breaker type shall comply with the recommendations in the coordination study and insure optimal code mandated time/current and instantaneous coordinated sequential tripping throughout the electrical system.
   The contract document intent requires providing the selection and use of the circuit breaker types and performance characteristics for time/current and instantaneous trip coordination during electrical circuit overload conditions and during electrical short circuit fault conditions. Combined with the specified circuit breaker protection time/current performance characteristics.
   a. Insulated Case Circuit Breaker type-ICCB:
      1) NEMA-AB1 and AB3, comply with latest revision.
      2) UL-1087, UL-489 and IEC-60.947, comply with latest revision.
      3) 5Hz AC closing and 3Hz AC trip and clear.
      4) Hybred combination of Molded Case Circuit Breaker type and Power Circuit Breaker type circuit breakers. ICCB enclosed insulated housing and limited internal maintenance access.
      5) Two-step stored energy close mechanism.
      6) Extended function on-off instantaneous trip selection.
      7) Push-to-trip button.
      8) Mechanical operations counter.
   b. Molded Case Circuit Breaker type-MCCB:
      1) NEMA-AB1 and AB3, comply with latest revision.
      2) UL-1087, UL-489 and IEC-60.947.2 rated devices, comply with latest revision.
      3) 5Hz AC closing and 3Hz AC trip and clear.
      4) Sealed enclosed housing.

B. Protection performance requirements for circuit breakers conforming to one or more of the following applications:
   600 Ampere or larger frame size.
   Larger than 400 Ampere trip.
   Service entrance in main switchboard or switchgear.
   Noted as Main or Main Circuit breakers on the drawings.

1. Circuit breaker shall employ current sensors and solid-state static digital electronic automatic trip system. Three phase, or single-phase operation as noted on the drawings. Current carrying components shall be completely isolated from the static trip units. The trip unit shall be independent of external power sources. Circuit breakers shall be rated for reverse connection.
2. Circuit breaker solid state digital trip control functions shall provide the following time/ current curve shaping field adjustable features;
   a. Adjustable ampere setting to vary the long-time continuous current carrying capacity, minimum range of 80% through 100% of full load trip rating.
   b. Adjustable long-time delay setting to vary the time the breaker will trip under sustained overload conditions. Minimum of three (3) settings, "minimum - intermediate - maximum".
   c. Adjustable short-time pickup to vary the level of high current the breaker can carry for short periods of time, minimum range of two (2) times through eight (8) times of ampere setting.
   d. Adjustable short time delay to vary the time of the short-time pickup. Minimum of three (3) settings "minimum-intermediate-maximum".
   e. Short time "I^2t" switch to allow a current-squared multiplied by time ramp function in the short-time system. Two (2) position setting "in-out".

f. Adjustable instantaneous pickup to vary the breaker ampere setting for immediate (instantaneous) interruption of severe overloads (short circuits). Adjustable minimum range of two (2) times through nine (9) times of circuit breaker ampere sensor rating. Instantaneous selective override trip setting shall also include “on-off” function. When “off”:, or “override” is selected, shall then function with the adjustable short time delay and adjustable short time pick-up (Note where the coordination study requires a higher instantaneous setting, change the specified adjustable instantaneous trip to fixed instantaneous trip at fifteen (15) times the breaker ampere sensor setting also with on-off function).

g. Individual fault trip indicators (flags) shall provide local indication on the breaker for overload and short circuit (and ground fault where applicable) conditions.

h. Provide quantity of one, manufacturer’s standard test set for solid state trip circuit breakers.

C. Protection performance requirements for circuit breakers conforming to one or more of the following applications:

Smaller than 600 ampere frame size.

400 ampere and smaller trip.

Larger than 100 ampere frame size.

Larger than 100 ampere trip.

1. Circuit breaker shall employ current sensors and solid-state static digital electronic automatic trip system. Time/current curve shaping field adjustable features
2. Solid state digital trip breakers shall conform to the requirements described above for solid state breakers larger than 400 ampere trip. However, only the following field adjustments are required;
   a. Long-time ampere setting adjustable minimum range of 80% through 100% of full load trip rating.
   b. Short time pickup adjustable minimum range of two (2) times through eight (8) times of the ampere setting.
   c. Fixed or field adjustable instantaneous trip (depending on the results of the coordination study).

D. Performance requirements for circuit breakers conforming to the following applications:

100 ampere frame size and smaller.

100 ampere and smaller trip.

1. Circuit breaker shall be fixed or adjustable instantaneous current trip with thermal-magnetic trip or with solid-state static digital electronic automatic time/over current automatic trip (depending on the results of the coordination study).

E. Current Limiting Circuit Breakers (CLCB)

1. Protection performance requirements for circuit breakers conforming to the following applications:

   600 ampere and smaller trip and identified as current limiting (CLCB) in the contract documents.

   a. Current limiting circuit breakers shall be supplied in integral fully enclosed insulating housing construction and shall consist of a common trip, thermal-magnetic or solid state static digital trip conventional circuit breaker (Depending on the results of the coordination study), with an independently operating limiter section in series with each pole.
   b. The conventional breaker section shall have an over center, trip-free, toggle-type mechanism with quick-make, quick-break action and positive handle indication. A button shall be provided on the cover for mechanically tripping the circuit breaker. The current limiting breaker shall have permanent trip units containing solid state static digital trip or individual thermal and magnetic trip elements, in each pole. Calibrated for 40-degrees C ambient temperature. The limiter section shall consist of current limiting

elements on each phase, electrically coordinated with the conventional circuit breaker trip elements. The contacts of the limiter section shall be electro-magnetically and electrodynamically opened and held open until interruption is complete.

c. Current and Energy Limitations: On high-level fault currents the limiter portion of the circuit breaker shall operate to limit the rise of fault current. Integral resistance shall be introduced into the faulted circuit to dissipate and limit let-through energy and to provide a voltage transient-free interruption at near unity power factor. The Let-through short circuit fault current and energy levels shall be less than that permitted by Underwriters Laboratories to a value less than I^2t of a half cycle wave of the symmetrical prospective current. The CLCB limiter shall limit the asymmetrical short circuit fault current below the equipment symmetrical short circuit fault current.

d. On fault currents below the threshold of current limitation, the normal non-limiter breaker section shall provide conventional time /current overload and short circuit fault protection.

2. Protection performance requirements for circuit breakers conforming to the following applications:

Trip ratings over 600ampere through 5000 ampere or less. Identified as current limiting (CLCB) in the contract documents.

a. Integrally fused circuit breaker integrated with solid state static digital electronic automatic trip. Combined standard circuit breaker providing overload-short circuit protection within its interrupting capacity and ON-OFF switching function and on each phase current limiters internally mounted on the load side of the circuit breaker, of such ratings that their time current limiting characteristics will coordinate with the time current tripping characteristics of the circuit breaker elements.

b. The coordination shall result in the interruption by the circuit breaker alone of fault level currents up to the interrupting capacity of the circuit breaker and interruption by the current limiter in conjunction with the circuit breaker of fault level currents above the interrupting capacity of the circuit breaker.

c. A removable cover shall be provided over the current limiter section of the integrally fused circuit breaker. The current limiter housing covers shall be interlocked with the breaker tripping mechanism to insure the breaker will trip upon removal of the cover. The cover shall be interlocked with the breaker to insure the circuit breaker cannot be turned to the ON position with the cover removed. Current limiters shall have a spring loaded plunger which, when the limiter blows, is released to actuate the circuit breaker common trip bar mechanism opening all breaker poles simultaneously.

d. The limiters shall be individually interlocked with the breaker element tripping mechanism to insure the limiter cannot be inserted until the breaker is in the OFF position. The circuit breaker and limiters shall be interlocked to insure the circuit breaker cannot be closed if a limiter is either missing or has blown.

e. Fuse limiters shall be individually removable from the circuit breaker housing.

f. The circuit breaker shall be ambient temperature compensating. The circuit breaker shall be provided with thermal magnetic or solid state static digital trip (depending on the coordination study).

g. The integrally fused circuit breaker shall be capable of interrupting available short circuit currents up to 200,000 RMS symmetrical amperes at voltage up to 600 VAC.

h. Ratings, clearances and performance of the integrally fused circuit breaker shall be in accordance with applicable standards of NEMA, IEEE and UL.

2.03 SWITCH AND FUSE FEEDER PROTECTIVE DEVICES

A. Fusible Switches: Quick-make, quick-break type with rejection clips for use with Class "R" fuses current limiting fuses (CLF). Switches with ratings up to and including 100 ampere at 240-volts shall be twins mounted. Switches rated through 60 amperes and 480 volts shall be twins mounted. Shall be UL listed suitable for normal and reverse feed. Switches shall be removable from front of switchboard without disturbing adjacent units or switchboard bus structure.

B. Fuses shall be time delay current limiting types, UL Class RK-1 unless otherwise indicated on the drawings. Provide one (1) spare set of fuses of each size and type in each switchboard.

C. Provide auxiliary contact on switch for remote status (on-off) signaling and monitoring. Provide conductor lugs to accept conductor temperature rating, sizes, and quantities shown on drawings.

2.04 GROUND FAULT PROTECTIVE SYSTEM AS FOLLOWS:

A. One control power transformer rated 480/120 volts of suitable capacity for shunt tripping of the main circuit breaker and subfeed circuit breakers as indicated on the drawings. Fuse transformer on the 480-volt side.

B. Ground sensor current transformer for each indicated ground fault relay, zero sequence type with integral test winding for each circuit indicated on drawings (The 3-phases and neutral conductor shall be brought through the current transformer window per manufacturer's recommendations). Shall be UL-listed suitable for normal and reverse feed.

C. One ground break, solid-state relay, and monitor and test panel for each device indicated on the drawings. Pick-up adjustment shall be continuous 100 through 1200 ampere; time adjustment shall be continuous from instantaneous through sixty (60) cycles. Monitor panel shall indicate relay operation and provide means for system testing with or without interruption of service, and shall not permit system to be inadvertently left in an inactive or off state. Provide resettable trip indicators.
   1. Ground fault system shall provide selective trip coordination with other upstream/down-stream ground fault and phase over current circuit protection devices as determined by the coordination study.
      a. Ground fault protection devices shall incorporate adjustable time/current trip settings.
      b. Ground fault protection devices shall incorporate adjustable inverse time and very inverse time adjustable/selective settings.

D. The ground fault system may be integrated into each circuit breaker with solid state trip units, in lieu of the separate specified ground fault relay and monitor panel system. The solid state circuit breaker ground fault system shall provide the identical specified operational features of the described separate system.

E. Each circuit breaker 100 ampere and larger, located in the main switchboard(s) and distribution switchboard or main switchgear where the main bus is larger than 800 ampere and operating above 240 volt phase-to-phase, shall be provided with ground fault system whether or not shown on the drawings. Provide all interconnecting control power and interlocking wire in switchboards/switchgear and between switchboards/switchgear for an operational system.

2.05 MAIN SWITCHBOARDS

A. Switchboard shall be floor-mounted, dead-front, dead-rear type, front and rear aligned, self-supporting, consisting of one or more vertical sections with bussing, circuit protective devices, instrumentation, auxiliary devices and control wiring as indicated on the drawings and as specified herein.
   1. Shall be utility and service entrance rated and approved.
   2. Switchboards shall employ mounting configuration for circuit protective devices as follows:
      a. Group-mount, fixed position, non-drawout switchboards. Front access only, shall not require rear access. Typical for all circuit protective devices or as indicated on drawings.
   3. Switchboards shall employ circuit breakers types and circuit protection devices as follows:
      a. All Main circuit breaker of all frame sizes – ICCB type circuit breakers.
      b. 800 ampere and larger frame size Feeder circuit breakers, ICCB type circuit breaker.
      c. Smaller than 800 ampere frame size Feeder circuit breakers, ICCB type; or MCCB type circuit breakers.

d. CLCB type circuit breakers. CLCB circuit type only where noted on the drawings.
e. CLF with switch and fuse type. CLF with switch and fuse type only where noted on the drawings.

4. Transient Voltage Surge Suppressor – TVSS
   a. Provide a 3-phase, 5-wire TVSS in the switchboard, with 30-ampere 3-pole subfeed circuit breaker.
   b. See Specifications Section 16050 for TVSS additional requirements.

B. Switchboard shall be designed, built and tested in accordance with applicable portion of the latest editions of NEMA PB-2, Underwriters Laboratories No. UL-891 and the National Electrical Code. Rated for service-entrance operation.

C. Switchboard sections configuration
1. Floor standing self-supporting, of the universal frame type using dieformed, 12-gauge steel members bolted and welded together.
2. Provide removable side and rear plates with formed edges all around.
3. Provide ventilation openings required for maintaining nominal operating temperature.
4. Provide removable steel cover plates for all usable device spaces. Provide lifting means and provisions for moving by means of rollers or skids to installation location.
5. Bolt individual sections together to form a single rigid switchboard assembly.
6. Provide full height, hinged, vertical wireway metal covers, on each vertical wireway, of each distribution section of the switchboard.
7. Typical for all switchboards, distribution switchboards and switchgear.

D. Switchboard shall include, but not be limited to, the following:
1. Underground pull section as required by the serving utility incoming service.
2. Metering facilities as required by the serving utility.
3. Current transformer space.
4. Main disconnects devices.
5. Distribution and feeder circuit protective devices.
6. District metering (where indicated on drawings).
7. Bussing, incoming utility compliant and outgoing distribution.
8. Transient Voltage Surge Suppressor Protection (TVSS).

2.06 DISTRIBUTION SWITCHBOARDS

A. Switchboards shall be floor mounted, dead-front, dead-rear type, front and rear aligned, self-supporting, consisting of one or more vertical sections with bussing, group mounted circuit protective devices, instrumentation and control wiring as indicated on the drawings and as specified herein. Switchboards shall comply with UL Standard #UL-891 and NEMA-PB2.
1. Distribution switchboards shall be service entrance rated and approved, when located in a building separate and remote from the main service entrance switchboard.
2. Distribution Switchboards shall employ circuit breaker types and circuit protection devices as follows:
   a. All Main circuit breakers of all frame sizes - ICCB type circuit breakers.
   b. 800 ampere and larger frame size Feeder circuit breakers, - ICCB; or MCCB type circuit breakers.
   c. Smaller than 800 ampere frame sizes Feeder circuit breakers - ICCB; or MCCB type circuit breakers.
   d. CLCB type circuit breakers, only where noted on the drawings.
   e. CLF with switch and fuse type. CLF with switch and fuse type only where noted on the drawings.

B. Distribution switchboards shall include but not be limited to the following:
1. Main disconnect device (where indicated on drawings).
2. Feeder protective devices.
3. District metering (where indicated on drawings).

4. Bussing.
5. Transient Voltage Surge Protection (TVSS).

C. Switchboard sections
1. Floor standing, self-supporting, of the universal frame type using dieformed, 12 gauge steel members bolted and welded together.
2. Provide removable side and rear plates with formed edges all around.
3. Provide ventilation openings required for maintaining nominal operating temperature.
4. Provide removable steel cover plates for all usable device spaces. Provide lifting means and provisions for moving by means of rollers or skids to installation location.
5. Bolt individual sections together to form a single rigid switchboard assembly.
6. Provide full height, hinged, vertical wireway metal covers, on each vertical wireway, of each distribution section of the switchboard.

2.07 MISCELLANEOUS INSTRUMENTS

A. Instrument and Control Transformers: ANSI C57.13 and NEMA ST20 as applicable. Transformers shall be specifically designed for use on respective protective relay or metering schemes utilized.

B. Current transformers meter/relay grade shall be multiratio tap, tap setting as indicated on drawings, (minimum of three (3) field adjustable tap settings) with 5 amp secondary, insulation class, 600 volt, 60Hz, single ring type, and shall have an accuracy classification of 0.3 with the burden of B.01, B.02 and B.03.

C. Control and transfer switches shall be of the rotary, oil-tight multiposition, cam-operated, multi-stage type, with dust cover and silver-to-silver contacts rated 600 volts, 20amp and adequate for the duty performed in excess of 10amp. Equip each switch with engraved plastic escutcheon nameplate identifying its function and position.

2.08 CONTROL WIRING

A. Terminal blocks with barriered terminals for each connection shall be provided for all control wiring terminator points. Control wiring shall be run in horizontal and vertical, isolated, internal metal wireways and shall be carried across hinges in laced bundles. Wire terminators shall be crimp-on type spade terminal

B. Secondary control wiring shall be a minimum of 14AWG stranded copper type SIS 600-volt insulation.

C. Control circuits shall have circuit number tags at each termination or break in the wire to match circuit numbers on terminal strips and control wiring diagrams.

2.09 WEATHERPROOF EQUIPMENT

A. Equipment indicated as weatherproof (W.P.) or outdoors should be NEMA 3R, non-walk-in, tamper resistant construction. Provide full height hinged doors with provisions for padlocking the doors in the closed position.

B. Provide a nominal 300-watt sealed, resistance type, anti-condensation heater in each equipment section. Heaters shall be controlled automatically by Thermostats and Humidstats. A circuit breaker shall be provided to supply switchboard buss voltage to the heaters, all prewired by the Manufacturer to fused terminals.

C. Finish shall be electrostatically applied finish paint over iron oxide rust inhibitor primer. Finish color shall be [manufacturer's standard color], [olive green Munsel #7GY3.29/1.5]. The bottom side and bottom 6-inches of the equipment shall be coated with 4-mil minimum thickness rust inhibitor undercoating over finish paint, on all interior surfaces. Finish withstand test without face corrosion or blistering:
1. Salt spray withstands - 2000 hours ASTM B117.

2. Humidity withstands - 750 hour ASTM D2247.

D. Exposed Hardware and Hinges Shall be Stainless Steel Type 302 or 304, Tamper Resistant

PART 3 - EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's written instructions and applicable portions of NECA's "Standards of Installations" for switchboards, switchgear and motor control centers.

B. Prior to energizing and testing, manufacturer's field engineer shall visually inspect and verify devices are operational and bus connects complete.

3.02 ANCHORING

A. Bolt equipment to floor and wall where wall exists. Where units are free standing, provide preformed steel channel or angle iron bracing to nearest wall or building structural member.

B. Equipment anchoring shall be designed for compliance with the earthquake seismic vertical and lateral acceleration of the equipment install location. Submit structural calculations and details.

3.03 FIELD TESTING INSPECTIONS AND COMMISSIONING (ADDITIONAL REQUIREMENTS)

A. Test all equipment after the installation has been completed, and the District's Representative has been given 10-days notice of the proposed tests. The CONTRACTOR shall provide operating tests demonstrating that all equipment and devices operate in accordance with the requirements of the documents.

B. Adjustable Settings
1. Shall be set and tested after the equipment installation is complete, for proper operation at set points, pickup, and/or drop-out points. Shall be performed by an independent test laboratory and trained certified technicians actively engaged in testing and using test instruments designed and manufactured for the purpose.
2. Provide protection device settings and test, to insure operation and coordination as described in the time/current coordination final submittal, and in accordance with the contract documents.
3. Calibrate and testing shall comply with the equipment manufacturer recommendations.
4. Correct deficiencies, non-compliant equipment and retest to demonstrate compliance.
5. Submit reports to District's Representative, six (6) copies.

3.04 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. Provide a red and white Bakelite nameplate with ½-inch high letters in each section fastened to face of dead-front plate, to read: "DANGER 480 (actual volts) VOLTS, KEEP OUT, AUTHORIZED PERSONNEL ONLY".

B. Manufacturer shall stencil the equipment name on each device and equipment section to correspond to the identification of the drawing.

C. Devices mounted in equipment controlling protective devices shall be provided with nameplates indicating device controlled or monitored.

END OF SECTION

BRANCH CIRCUIT PANELBOARDS AND TERMINAL CABINETS

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment 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 specification sections and drawings for related work required to be included as work under Division 26.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Provide manufacturers catalog data for panels, cabinets, and circuit breakers.

B. Provide Shop Drawing showing panel circuit arrangements, size, voltage, ampacity, overcurrent protective devices, etc.

C. Provide nameplate engraving schedule.

D. Short Circuit, Coordination and ARC-FLASH
   1. Perform and submit engineered settings for each equipment location, fuse and adjustable circuit breaker device, showing the correct time and settings to provide the selective coordination within the limits of the specified equipment, per the latest applicable standards of IEEE and ANSI. Provide electrical system short circuit fault analysis, both 3-phase line-to-line and 1-phase line-to-ground calculations as part of the coordination analysis recommendations. Provide Electric ARC-FLASH calculations as part of the coordination analysis recommendations.
   2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an engineering narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six (6) copies.
   3. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified contract equipment. Shall comply with, but not limited to:
      a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
      b. IEEE-399, Recommended Practice for Industrial and Commercial Power System Analysis.
      c. IEEE-1584, Guide to Performing ARC-FLASH Hazard Study.
      d. CEC/NEC
   4. Electrical equipment including switchgear, switchboards, electrical panels, and control panels, transformers, disconnects, etc., shall each be labeled by the manufacturer with “Electrical-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, to wear the correct protective equipment/clothing (PPE) when working “Live”, or operating “Live” equipment and circuits.

1.03 SEISMIC EARTHQUAKE AND WIND LOADING WITHSTAND, TESTING AND CERTIFICATION. (ADDITIONAL REQUIREMENTS)

A. General

1. The complete panels and terminal cabinet assemblies; including circuit protection devices, meter, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested.
   a. Wind loading all outdoor equipment locations.
   b. Earthquake seismic zone-4 and CBC/IBC Seismic withstand, all indoor and all outdoor equipment locations.
2. Shall withstand, survive and maintain continuos non-interrupted energized operation during the seismic event occurrences and wind event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation. Acceptance test seismic qualification shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
4. Provide three (3) dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading not less than as follows and as required by AHJ:
   a. 100MPH – West coast states USA and Hawaii.
   b. 150MPH – East coast states USA, Gulf coast states USA and Alaska state.
   c. 90MPH – all other USA locations.
5. Seismic test shall be performed by a third party independent test laboratory. Wind analysis and seismic Testing and reports shall be certified, signed and “stamped” by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.

PART 2 - PRODUCTS

2.01 PANELBOARDS AND DISTRIBUTION PANELS

A. Shall be flush or surface mounting as indicated with group -mount circuit protection devices as shown on panel schedule, hinged lockable doors, index cardholders and proper bussing.
   1. Panelboards shall comply with the latest versions:
      a. NEMA – PB1.
      b. UL – 50 and 67.
      c. CEC/NEC.
      d. ASTM-B187.
   2. Where indicated on the drawings shall be furnished with subfeed breakers and/or additional conductor lugs, split bussing, contactors, time switches, relays, etc., as required.
      a. Branch circuit panels up through forty-two (42) circuits shall be single section, to accommodate all of the circuits and components.
      b. Distribution panels shall be single section or multi-section, to accommodate all of the circuits and components.
   3. Panels shall be “Service-Entrance” equipment rated when the panel main incoming supply feeder originates from one of the following:
      a. Originates outdoors exterior of the building in which the respective panel is located.
      b. Originates from an electrical supply source not located in the same building as the respective panel.

B. Housing and Painting, Panels and Terminal Cabinets
   1. Shall be finished with one (1) coat of rust inhibitor zinc chromate and coat of primer sealer after a thorough cleaning.
   2. Finish color paint as selected by DISTRICT ’s Representative where exposed to public view (e.g., corridors, covered passages, offices, etc.). Prime coated panelboard shall be painted to match surroundings after installation in public areas.
   3. Manufacturer’s standard color in electrical rooms/closets, janitor's, HVAC and storage rooms.
   4. Shall be fabricated of sheet steel of the following minimum gauges.
      a. Full height hinged, locking door. Trim #12 gauge steel; enclosure - code gauge steel.

b. Panels installed in indoor dedicated electrical equipment rooms and dedicated electrical equipment closets, omit full height hinged locking panel door. Dead front cover behind omitted panel door shall remain.

5. NEMA-1 Metal Housing, for indoor locations.
6. NEMA-3R Metal Housing, tamper resistant, for outdoor locations.
7. Furnish all panels and terminal cabinets with the manufacturers flush locks and keys except where indicated otherwise herein. Keys and locks shall be interchangeable for all panels. Provide two (2) latches and two (2) locks for door heights exceeding 36-inches.
8. Fasten the trim to panel and terminal cabinets by means of concealed, bolted or screwed fasteners accessible only when the door is open.

C. Panels 208/120 volt, three phase, 4-wire, S/N or 120/240 volt, single phase, 3-wire, S/N.
Branch circuit panel as manufactured by:
1. Cutler Hammer "Pow-R-Line 1 or 2" Series
2. General Electric "A" Series
3. Square D "NF/NQ" Series
4. Siemens "P1/P2" Series

D. Branch circuit panels for 480/277 volt, three phase, 4 wire, S/N.
Panelboard as manufactured by:
1. Cutler Hammer..... "Pow-R-Line 2" Series
2. General Electric..... "A" Series
3. Square D ..... "NF" Series
4. Siemens ..... "P1/P2" Series

E. Distribution panels as manufactured by:
1. Cutler Hammer "Power-R-Line 3 or 4" Series
2. General Electric "Spectra" Series
3. Square D "I-Line" Series
4. Siemens "P4/P5" Series

F. Top and bottom gutter space shall not be less than 6-inches high. Provide 6-inches additional gutter space in all panels where double lugs are required, or where cable ampere size exceeds bus ampere size. Provide 12-inches additional gutter space in all panels for aluminum feeders where used.

G. Panel dimensions.
1. Panels with buss sizes 50 ampere thru 400 ampere
   a. Shall be 20-inches wide. Surface or flush mounting as indicated.
   b. Recess mounted type shall have a 20-inches wide (maximum) recess metal enclosure with overlapping edge trim plate cover extending 1-inch on all sides of enclosure.
   c. Depth shall be 5.75-inches nominal. Height of panel as required for devices.
2. Panels with buss sizes greater than 400 ampere
   a. Narrow panels 24-inches (maximum) wide by 6.5-inches (maximum) deep units. Wide panels 25-inches to 44-inches (maximum) wide by 8-inches to 15-inches (maximum) deep units. Nominal 90-inch panel height.
   b. The wider units shall be used only at locations where the narrow unit is not available with the quantity or size of large-ampere frame branch/subfeed circuit protective devices shown on the panel schedules, or where the main breaker size exceeds the narrow panel maximum.
   c. Distribution panels shall be floor standing and also supported from behind the panels at walls.

H. Distribution panels and branch circuit panels maximum load rating
1. Panelboards and Distribution Panels exceeding 800-ampere load rating shall not be permitted.
2. Provide Distribution Switchboards instead of Distribution Panels for bus load and circuit load ratings exceeding 800 ampere.

I. Panel Auxiliary Cabinets
   1. Panelboards shown on the drawings with relays, time clocks or other control devices shall have a separate auxiliary metal barriered compartment mounted above panel.
   2. Panelboards with circuits controlled by low voltage remote control relays shall be provided with separate auxiliary cabinets to contain the relays, adjacent to the panelboard.
   3. Provide auxiliary cabinets with separate hinged locking door to match panelboard.
   4. Provide mounting subbase in cabinet for control devices and wiring terminal strips.

J. Panels shall have a circuit index cardholder removable type, with clear plastic cover. Index card shall have circuit numbers imprinted to match circuit breaker numbers.
   1. The panel identification nameplate shall describe the respective panel name and voltage, corresponding to the contract documents.
   2. The electrical power source, name and location of each panel supply-feeder and supply equipment name shall also be identified and described on the respective panel nameplate.

K. TVSS - Transient Voltage Surge Suppresser
   1. Provide each of the following branch circuit panel and distribution panel types with a TVSS and RF filtering:
      a. 208/120 volt - single phase and/or three phase.
      b. 120/240 volt - single phase.
      c. 480/277 volt - single phase and/or three phase.
      d. All distribution panels.
   2. The TVSS shall be installed inside the respective panel housing and shall be factory connected to each main phase, ground and neutral bus inside the panel.
   3. The TVSS monitor/annunciator indicators shall be visible only when the panel access door is in the open position.
   4. Provide a 20-ampere 3-pole (2-pole for single-phase panels) branch circuit protection device in each panel for TVSS connection.
   5. The TVSS device and panel shall be UL labeled and listed for combined use. See related specification sections for additional TVSS requirements.

L. Seismic Earthquake and wind loading withstand, testing and certification (ADDITIONAL REQUIREMENTS)
   1. The complete panel/panelboard assembly; including circuit protection devices, housings/ enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested for wind loading and earthquake seismic zone-4 withstand.
   2. Shall withstand, survive and maintain continuos non-interrupted energized operation (running) during the seismic event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
   3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation.
   4. Provide three (3) dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading as follows:
      a. 100MPH – West coast states USA and Hawaii.
      b. 150MPH – East coast states USA, Gulf coast states USA and Alaska state.
      c. 90MPH – all other USA locations.
   5. Acceptance test seismic qualification of proposed panels and panelboards shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
   6. Seismic test shall be performed by a third party independent test laboratory. Wind analysis and seismic Testing and reports shall be certified, signed and “stamped” by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.

2.02 Short Circuit Rating

A. Circuit protective devices and bussing as indicated on the drawings. All devices and bussing shall have a short circuit fault withstand and interrupting capacity not less than the maximum available fault current at the panel and as indicated on the drawings, plus a 25% additional capacity (safety margin). However, in no case shall the short circuit fault interrupting and withstand capacity be less than the following symmetrical short circuit.

C/B and/or Bus Rating	Circuit Voltage	Short Circuit Amp.
1. 400A and less	240V and below	10,000A
2. 400A and less	over 240V and below 600V	14,000A
3. Over 400A & 800A & below	240V and below	42,000A
4. Over 400A & 800A & below	over 240V and below 600V	30,000A

B. Panel short circuit fault rating
   1. General
      a. Provide a "fully rated" for short circuit fault interrupt and full load ampere main circuit breaker in each branch circuit panel and/or each distribution panel. Provide the main circuit breaker whether or not a main circuit breaker is shown otherwise on the drawings, schedules or diagrams. The "utility-source" plus the "motor-load" transient contributions shall be used to establish the available fault duty values, unless indicated otherwise on the drawings.
      b. The panel main circuit breaker full load ampere capacity rating shall equal the respective panel main bus ampere rating.
      c. The panel assembly, buss and circuit protection devices bolted fault short circuit withstand and bolted fault short circuit interrupt ratings shall not be less than 125% greater (including a 25% safety margin) than the available utility-source symmetrical and asymmetrical bolted fault short circuit current when "series combined rated" with the panel main circuit breaker.
      d. The main circuit breaker rated "bolted-fault" short circuit fault interrupt and withstand short circuit rating shall not be less than 125% (including a 25% safety margin) of the upstream main service entrance "bolted-fault" available (symmetrical and asymmetrical) short circuit current.
   2. Distribution Panelboards
      a. Distribution panel, main circuit breaker, all feeder circuit breakers, and all branch circuit breakers shall be "fully-rated" (plus safety margin) for the available bolted fault short circuit current (including safety margin).
      b. Shall provide time/current-tripping coordination with downstream equipment and upstream equipment.
   3. Non-emergency branch circuit panelboards 400-ampere buss and smaller; Non-emergency branch circuit panelboards 400-ampere trip main circuit breaker and smaller.
      a. The branch circuit panel main circuit breaker shall be "fully-rated" (plus safety margin) Current Limiting Circuit Breaker type (CLCB). Shall provide time/current- tripping coordination with upstream equipment.
      b. The branch circuit panel main circuit breaker shall be "series-rated" with the panel downstream branch circuit devices and panel bussing. "The series-rating" shall provide short circuit bolted fault current withstand protection and short circuit bolted fault interrupt rating protection during a downstream 3-phase line-to-line and/or single-phase line-to-ground short circuit bolted faults.
      c. Typical for branch circuit panelboards connected to normal-power (non-emergency) power circuits.
   4. Emergency branch circuit panelboards 400-ampere bus and smaller; Emergency branch circuit panelboards 400-ampere trip main circuit breaker and smaller.
      a. The branch circuit panel main circuit breaker shall be short circuit bolted fault "fully-rated" (plus safety margin) non-Current Limiting circuit breaker type (non-CLCB).
      b. The panel bussing shall also be short circuit bolted fault "fully-rated".

c. All of the branch circuit panel, branch circuit breakers shall be “fully-rated” non-fused Current Limiting Circuit Breaker Type (CLCB). Shall provide short circuit bolted fault interrupt rating. Coordinated time/current and instantaneous tripping with the upstream circuit protection devices.
d. Typical for branch circuit panelboards connected to emergency power circuits.

2.03 PANEL CIRCUIT BREAKERS, CIRCUIT PROTECTION DEVICES

A. Circuit Breakers General, for Distribution Panels and Panelboards
1. NEMA-AB1 and AB3, comply with latest revision.
2. UL-1087, UL-489 and IEC-60.947.2 rated devices, comply with latest revision.
3. 5Hz AC closing and 3Hz AC trip and clear.
4. Main circuit breakers for distribution panels exceeding 400 ampere and larger;
   a. Shall be Insulated Case Circuit Breaker type ICCB.
5. Main circuit breakers for branch circuit panelboards 400 ampere buss and smaller;
   a. Shall be Current Limiting Circuit Breaker type-CLCB for non-emergency panelboards.
   b. Shall be Molded Case Circuit Breaker type-MCCB for emergency panelboards.
6. Branch circuit breakers and feeder circuit breakers smaller than 100-ampere trip shall be Molded Case Circuit Breakers type-MCCB and/or Current Limiting Circuit Breakers type-CLCB.
7. All circuit breakers 100 ampere and larger trip shall employ sensors and solid state digital electronic automatic trip system. Short-time and long-time Time/current curve shaping field adjustable functions and adjustable instantaneous trip. Typical for Molded Case Circuit Breaker type-MCCB, Insulated Case Circuit Breaker type-ICCB and Current Limiting Circuit Breaker type-CLCB.
8. Refer to Specification Section 16425 and/or 16312 for additional circuit breaker requirements.

B. Manufacturer
1. Circuit breakers as manufactured by the following companies only are acceptable:
   a. Cutler Hammer
   b. General Electric Co.
   c. Square D Co.
   d. Siemens

C. Configuration
1. Circuit breakers shall be arranged in the panels so that the breakers of the proper trip settings and numbers correspond to the numbering in the panel schedules on the drawings.
2. Circuit numbers of breakers shall be black-on-white micarta tabs or other previously approved method. Circuit number tabs, which can readily be changed from front of panel, will not be accepted. Circuit number tabs shall not be attached to or be a part of the breaker.
3. Panelboard circuit protection devices shall be bolt on type for connection to panel bus. Removable and installable without disturbing adjacent devices.
4. Provide conductor wire terminations (lugs) on each circuit protection device for incoming main feeder, branch circuits and outgoing feeder circuits. Dual rated copper/aluminum and compatible with the respective conductor size, type, and quantity.
5. Where 2-pole or 3-pole breakers occur in the panels, they shall be common trip units. Single pole breakers with tie-bar between handles will not be accepted.
6. Branch circuit panels shall be field convertible for bottom entry main incoming feeder or top entry main incoming feeder.
7. Each panel section, the feeder and branch circuit protection devices (3-phase and/or 1-phase) shall be “twin-mount”, side-by-side double row construction for the following circuit sizes:
   a. 480/277 volt, 60-ampere circuit size and smaller.
   b. 240 volt – 208/120 volt, 100 ampere circuit size and smaller.

D. Lock-Off and Lock-On
   1. All circuit breakers shall be pad-lockable in the "off" position.
   2. Where branch circuit breakers supply the power to motors and signal systems, the breakers shall also be furnished with lockout clips, mounted in the “on” position. The breakers shall be able to trip automatically with lockout clips in place.
   3. Provide lock-on clips on branch circuit breakers supplying fire alarm equipment and fire alarm panels. Provide identification of the dedicated "fire alarm" circuit function and operation. Color-code the circuit breakers to comply with AHJ requirements.
   4. Locking facilities shall be riveted or mechanically attached to the circuit breaker (submit sample for approval. Other means of attachment shall not be accepted without prior written approval of the District's Representative.

E. ARC Fault Interrupter Circuit Breaker (AFCI-C/B)
   1. AFCI-C/B provides automatic circuit interruption upon detection of any of these conditions: overload, short circuit fault and electric branch circuit arcing protection.
   2. The AFCI-C/B shall detect intermittent “arcing” type electrical faults, and provide automatic circuit interruption (tripping).
   3. Provide “test-pushbutton” on each C/B for manual AFCI-C/B testing.
   4. Single pole, 120-volt, 60Hz AC UL listed and labeled for installation in panelboard, #14 - #8AWG solid/ stranded AL/CU load conductor.

F. Switch and Fuse Feeder Protective Devices for Distribution Panels
   1. Locations where the drawings show distribution panels employing switch-fuse circuit protection devices.
   2. Fusible Switches: Quick-make, quick-break type with rejection clips for use with Class “R” fuses current limiting fuses (CLF). Switches with ratings up to and including 100 ampere at 240 volts shall be twins mounted. Switches rated through 60 ampere and 480 volts shall be twins mounted. Provisions for padlocking in the “on” and/or “off” positions. Switches shall be removable from front of panel without disturbing adjacent units or panel bus structure.
   3. Fuses shall be time delay current limiting types, UL Class RK-1 unless otherwise indicated on the drawings. Provide one (1) spare set of fuses of each size and type in each Distribution Panel.
   4. Provide auxiliary contact on switch for remote status (on-off) signaling and monitoring. Provide conductor lugs to accept conductor temperature rating, sizes and quantities shown on drawings.
   5. Switch and fuse devices shall be permitted only in distribution panels and only where specifically indicated on the drawings for feeders.

2.04 PANEL BUSSING

A. Bus Material
   1. Bussing shall be rectangular cross section tin-plated copper or alternately silver or tin-plated aluminum.
   2. Bussing shall be non-tapped, full length of the enclosure.

B. Ground Bus
   1. Each panel 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.

C. Provisions
   1. Provide space and all hardware and bus mounting attachments for future devices as indicated on the drawings.

D. Neutral Bus
   1. The ampere rating of the neutral bus of panels and distribution panels shall be a minimum of 100% greater ampere capacity than the ampere rating of the corresponding phase bus, where the panel is indicated to be provided with an “oversize-neutral” or “200%” neutral on the drawings.

2.05 TERMINAL and AUXILIARY CABINETS

A. Cabinets
   1. Fabricated of code gauge sheet steel for flush mounting (except where noted as surface) of size indicated on the drawings, and complete with hinged lockable doors, provide the quantity of 2-way Feed through conductor terminals required for termination of all conductors, plus 15% spares of each type.
   2. Cabinet locks to operate from same key used for panelboards. The trim to cabinets shall be fastened by means of concealed bolted or screwed fasteners accessible behind door into cabinets. All cabinets shall have ⅝-inch plywood backing, finished with fireproof intumescent primer and finish coat paint. Provide equipment ground bus in each cabinet.
   3. Cabinets shall be finished with one coat of zinc chromate and one coat of primer sealer after a thorough cleaning. Where exposed to public view (e.g., corridors, covered passages, offices, etc.) finish color paint to match surrounding and manufacture’s standard gray color in switchboard, janitors, heater and storage rooms.
   4. Provide grounded metal barriers inside cabinet to isolate and separate line voltage and low voltage from each other inside the cabinet.

B. Cabinet dimensions.
   1. Unless indicated otherwise on drawings.
      a. Shall be 20-inches wide. Surface or flush mounting as indicated.
      b. Recess mounted type shall have a 20-inches wide (maximum) recess metal enclosure with overlapping edge trim plate cover extending 1-inch on all sides of enclosure.
   2. Depth shall be 5.75-inches nominal. Height of cabinet as required for devices, plus 25% spare unused interior space for future use, but not less than 36-inches high.

C. Terminals
   1. Non-digital analog circuits; line and low voltage modular signal systems, 15-ampere dual row with isolation barriers, screw-down terminals insulated strips, heavy duty.
      a. As manufactured by Molex, or ITT-Cannon, or General Electric.
   2. Digital circuits; low voltage signal systems, ANSI/ EIA/TIA Category-6, 110-Block or 66-Block gas-tight punch down style, heavy duty.
      a. As manufactured by: Leviton, or Ortronics, or AMP.

D. Identification (additional requirements)
   1. Provide engraved nameplate on each cabinet indicating its designation and system (i.e., “Life Safety System - Panel 2LS”, etc.).
   2. Identify each terminal landing with unique circuit number and provide corresponding alphanumeric text-index card inside panel access door

PART 3 - EXECUTION

3.01 MOUNTING

A. Flush mounted panelboards and terminal cabinets shall be securely fastened to at least two studs or structural members. Trim shall be flush with finished surface.
   1. Panels and cabinets installed flush (recess or semi-recess) into fire rated or smoke rated walls. The wall recess shall be fully wrapped inside the recess with fire/smoke rated materials. The wrap-materials shall provide the same fire and/or smoke protection rating as the respective wall.

B. Surface mounted panels and terminal cabinets shall be secured to walls by means of preformed galvanized steel channels securely fastened to at least two (2) studs or structural members.

C. Panelboards and terminal cabinets shall be installed to insure the top circuit protective device (including top compartment control devices) are not more than 6-feet-6-inches above finish floor in front of the panel and the bottom device is a minimum of 12-inches above the floor. Manufacturer shall specifically indicate on shop drawing submittals each panel where these conditions can not be met.

3.02 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. Provide a red and white Bakelite nameplate with ½-inch high letters in each 277/480 volt panel fastened to face of dead-front plate, to read: "DANGER 480 (or as applicable) VOLTS KEEP OUT AUTHORIZED PERSONNEL ONLY".

B. Manufacturer shall stencil the panel/cabinet number identification on the inside of door to correspond with the designation on the drawings.

C. Identification plates and numbers shall be attached with screws or twist lock fasteners. Adhesive attachment of any kind shall not be used.

3.03 SPARE CONDUITS (ADDITIONAL REQUIREMENTS)

Provide three (3) 1-inch conduit only stubs from each panel and terminal cabinet into accessible ceiling space. Where floor level below panel or terminal cabinet is accessible, also provide an additional three (3) 2-inch conduit only stubs into accessible floor space.

END OF SECTION

SECTION 26 24 19
MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment 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 specification sections and drawings for related work required to be included as work under Division 26.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Provide schematic "ladder-type" logic control wiring diagrams and "point-to-point" control wiring diagrams showing the control system for HV/AC equipment and other electrical equipment.

B. Provide nameplate engraving schedule.

C. Submit full-scale time/current transparencies on log/log paper for all fuses, circuit breakers, ground fault system devices, and relays.

D. SHORT CIRCUIT, COORDINATION AND ARC-FLASH
   1. Perform and submit engineered settings for each equipment location, fuse and adjustable circuit breaker device, showing the correct time and current settings to provide the coordination within the limits of the specified equipment, per the latest applicable standards of IEEE and ANSI. Provide electrical system short circuit fault analysis, both 3-phase line-to-line and 1-phase line-to-ground calculations as part of the coordination analysis recommendations. Provide Electric ARC-FLASH calculations as part of the coordination analysis recommendations.
   2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an engineering narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six (6) copies.
   3. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified contract equipment. Shall comply with, but not limited to:
      a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
      b. IEEE-399, Recommended Practice for Industrial and Commercial Power System Analysis.
      c. IEEE-1584, Guide to Performing ARC-FLASH Hazard Study.
      d. CEC/NEC
   4. 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 “Electrical-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.

PART 2 - PRODUCTS

2.01 GENERAL

A. Division 240000 HVAC/Plumbing
Refer to Division 260000 Mechanical and Plumbing Contract Documents and shop drawings for additional electrical work and material requirements.
1. Provide all control devices including timeswitches, relays, auxiliary contacts, voltage transformers, and interlocks.
2. Provide all raceways, conduit wire, circuits, outlets, and interconnections of starters as required for HVAC and Plumbing systems.

B. Special Considerations
1. Mount all auxiliary relays and timeswitches in an isolated compartment inside motor control equipment unless otherwise indicated.
2. Whether or not shown on mechanical and plumbing Contract Documents and/or control schedules, where motors are controlled by external devices (i.e., thermostats, relays, float or pressure switches, etc.) or interlocked with other motors, provide each magnetic motor starter with a "Hand-Off-Auto" selector switch in starter cover. Other magnetic motor starters provide a "Start-Stop" push-button station in starter cover.
3. Motor starters, motor controllers and circuit feeder tap devices for motor circuits shall be rated and labeled for control of all electric motor design types A, B, C, D, and E pursuant to the requirements of the NEC

C. Seismic Earthquake and wind loading withstand, testing and certification (ADDITIONAL REQUIREMENTS)
1. The complete motor control equipment assembly; including circuit protection devices, motor controllers, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested.
   a. Wind loading for outdoor locations.
   b. Earthquake seismic zone-4 withstand and CBC/IBC Seismic withstand, all indoor and all outdoor equipment locations.
2. Shall withstand, survive and maintain continuos non-interrupted energized operation (running) during the seismic event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation.
4. Provide three (3) dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading not less than as follows and as required by AHJ:
   a. 100MPH-West coast states USA and Hawaii.
   b. 150MPH-East coast states USA, Gulf coast states USA and Alaska state.
   c. 90MPH-all other USA locations.
5. Acceptance test seismic qualification of proposed motor control equipment shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
6. Seismic test shall be performed by a third party independent test laboratory. Wind analysis and seismic Testing and reports shall be certified, signed and “stamped” by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.

D. Motor control equipment as manufactured by:
1. General Electric; or Square D; or Cutler-Hammer; or Allen-Bradley; or Siemens.

2.02 MANUAL MOTOR STARTERS

A. Provide flush or surface mounting manual motor starters with number of poles and size of thermal overload heaters as required for the motor being controlled (equipped with overload

heaters, one (1) for each motor lead). Back boxes shall be supplied with all flush mounting starters, whether they are toggle type requiring only a 4-inch square outlet box or the larger type requiring a special box. Provide cover designed to accept the particular unit.

B. Unless otherwise noted on the drawings, all manual starters for single phase motors, smaller than 1 h.p. shall be the compact toggle type. Manual starters for all single phase motors, 1 to 5 h.p. and all three phase motors up to 5 h.p. shall be the heavy-duty type.

C. Where manual motor starter is shown with pilot light, the pilot light shall be installed in a separate outlet box adjacent to the starter outlet with engraved nameplate to indicate function of pilot light. Pilot lights shall be push-to-test style.

2.03 FEEDER TAP DEVICES

A. General
1. Feeder tap devices shall be coordinated with the motor starter unit's electrical and mechanical characteristics. Operating handle shall be accessible and operable from the unit front with positive visible indication of the on, off and tripped operating handle positions.
2. Feeder tap devices shall have a short circuit and motor locked rotor interrupting capacity, series rated with the respective motor starter of not less than the maximum available fault current at the device as indicated on the drawings, but in no case shall the interrupting capacity be less than 30,000 ampere symmetrical interrupting for 480/277 volt devices and 42,000 ampere symmetrical for 240 volt or 208/120 volt devices. Provide four key interlocking and padlock-off devices on each feeder tap unit.
3. Feeder tap device (i.e. circuit breakers, switch and fuse or motor circuit protector) shall be as indicated on the drawings. Where feeder tap device type is not indicated, provide switch and fuse type device.
4. Circuit breakers shall provide time overcurrent and instantaneous circuit protection. Motor circuit protectors shall provide instantaneous magnetic only circuit protection. Feeder tap devices shall be UL component listed and rated with the respective motor starters.
5. Feeder tap device shall provide an auxiliary contact to automatically connect and disconnect control power when the feeder tap device is open, tripped or closed.
6. Provide an auxiliary contact on feeder tap device for remote status (on-off) signaling and monitoring.
7. Provide conductor lugs to accept conductor temperature rating, sizes, and quantities shown on the drawings.

B. Feeder tap devices shall be as indicated on the drawings:
1. Circuit breaker feeder tap
a. Circuit breakers shall employ a stored energy, quick make-quick break, and trip free operating system on each phase, with common trip. Breakers shall comply with U.L. 489 and 1087, NEMA AB1 AB3 latest revisions. Circuit breakers noted as "100%" on the drawings shall be rated to carry the breaker full rated (100%) ampere load continuously.
b. Protection performance requirements for circuit breakers conforming to one or more of the following applications:
600 Ampere or larger frame size.
Larger than 400 ampere trip.
Service entrance motor control center.
Noted as main circuit breakers on the drawings.
1) Circuit breaker shall employ current sensors and solid state static digital electronic automatic trip system. Three phase, or single-phase operation as noted on the drawings. Current carrying components shall be completely isolated from the static trip units. The trip unit shall be independent of external power sources. Circuit breaker shall be U.L. listed for reverse connection.

2) Circuit breaker solid state trip control functions shall provide the following time/ current curve shaping field adjustable features;
   a) Adjustable ampere setting to vary the long-time continuous current carrying capacity, minimum range of 80% through 100% of full load trip rating.
   b) Adjustable long-time delay setting to vary the time the breaker will trip under sustained overload conditions. Minimum of three settings, "minimum - intermediate - maximum".
   c) Adjustable short-time pickup to vary the level of high current the breaker can carry for short periods of time, minimum range of 2 times through 8 times of ampere setting.
   d) Adjustable short time delay to vary the time of the short-time pickup. Minimum of three settings "minimum-intermediate-maximum".
   e) Short time "I^2t" switch to allow a current-squared multiplied by time ramp function in the short-time system. Two (2) position setting "in-out".
   f) Adjustable instantaneous pickup to vary the breaker ampere setting for immediate (instantaneous) interruption of severe overloads (short circuits). Adjustable minimum range of 2.0 times through 13 times of circuit breaker ampere sensor rating. Circuit breaker shall incorporate adjustable instantaneous trip settings to allow coordinated instantaneous trip settings when protecting energy efficient motors.
   g) Individual fault trip indicators shall provide local indication on the breaker for overload and short circuit (and ground fault where applicable) conditions.
   h) Provide one manufacturer standard test set for solid state trip circuit breakers.

c. Protection performance requirements for circuit breakers conforming to one or more of the following applications:
   Smaller than 600 ampere frame size.
   400 ampere and smaller trip.
   Larger than 100 ampere frame size.
   Larger than 100 ampere trip.
   1) Circuit breaker shall employ current sensors and solid-state static digital electronic automatic trip system. Time/current curve shaping field adjustable features.
   2) Solid state trip breakers shall conform to the requirements described above for solid state breakers larger than 400 ampere trip. However, only the following field adjustments are required;
      a) Ampere setting adjustable minimum range of 80% through 100% of full load trip rating.
      b) Short time pickup adjustable minimum range of 2 times through 8 times of the ampere setting.
      c) Adjustable instantaneous trip (circuit breaker shall incorporate adjustable instantaneous trip settings to allow coordinated instantaneous trip settings when protecting energy efficient motors).

d. Performance requirements for circuit breakers conforming to the following applications:
   100 ampere frame size and smaller.
   100 ampere and smaller trip.
   1) Circuit breaker shall be fixed or adjustable instantaneous trip with thermal-magnetic trip or with solid-state static digital electronic automatic time/over current automatic trip depending on the results of the coordination study.

e. Current Limiting Circuit Breakers (CLCB):
   1) Performance requirements for circuit breakers conforming to the following applications:
      600 ampere and smaller trip and identified as current limiting (CLCB) on the drawings.
      a) Current limiting circuit breakers shall be supplied in unit molded case construction and shall consist of a common trip, thermal-magnetic or solid state

trip circuit breaker with an independently operating limiter section in series with each pole.

b) The conventional breaker section shall have an over center, trip-free, toggle-type mechanism with quick-make, quick-break action and positive handle indication. A button shall be provided on the cover for mechanically tripping the circuit breaker. The current limiting breaker shall have permanent trip units containing solid state static digital trip or individual thermal and magnetic trip elements in each pole. Calibrated for 40 degrees C ambient temperature. The limiter section shall consist of three current limiting elements electrically coordinated with the conventional circuit breaker trip elements. The contacts of the limiter section shall be electro-magnetically and electrodynamically opened and held open until interruption is complete.

c) Current and Energy Limitations: On high-level fault currents the limiter portion of the circuit breaker shall operate to limit the rise of fault current. Integral resistance shall be introduced into the faulted circuit to dissipate and limit let-through energy and to provide a voltage transient-free interruption at near unity power factor. The Let-through short circuit fault current and energy levels shall be less than that permitted by Underwriters Laboratories to a Value less than I^2t of a half cycle wave of the symmetrical prospective current. The CLCB limiter shall limit the Asymmetrical short circuit fault current below the equipment symmetrical short circuit fault current.

d) On fault currents below the threshold of current limitation, the thermal-magnetic breaker section shall provide conventional overload and short circuit protection.

2) Performance requirements for circuit breakers conforming to the following applications:

Trip ratings over 600 ampere. Identified as current limiting (CLCB) on the drawings.

a) Integrally fused circuit breaker integrated with solid state static digital electronic automatic trip. Combined standard circuit breaker providing overload-short circuit protection within its interrupting capacity and ON-OFF switching function and on each phase current limiters internally mounted on the load side of the circuit breaker, of such ratings that their time current limiting characteristics will coordinate with the time current tripping characteristics of the circuit breaker elements.

b) The coordination shall result in the interruption by the circuit breaker alone of fault level currents up to the interrupting capacity of the circuit breaker and interruption by the current limiter in conjunction with the circuit breaker of fault level currents above the interrupting capacity of the circuit breaker.

c) A removable cover shall be provided over the current limiter section of the integrally fused circuit breaker. The current limiter housing covers shall be interlocked with the breaker tripping mechanism to insure the breaker will trip upon removal of the cover. The cover shall be interlocked with the breaker to insure the circuit breaker cannot be turned to the ON position with the cover removed. Current limiters shall have a spring loaded plunger which, when the limiter blows, is released to actuate the circuit breaker common trip bar mechanism opening all breaker poles simultaneously.

d) The limiters shall be individually interlocked with the breaker element tripping mechanism to insure the limiter cannot be inserted until the breaker is in the OFF position. The circuit breaker and limiters shall be interlocked to insure the circuit breaker cannot be closed if a limiter is either missing or has blown.

e) Fuse limiters shall be individually removable from the circuit breaker housing.

f) The circuit breaker shall be ambient temperature compensating. The circuit breaker shall be provided with thermal magnetic or solid state static digital trip (depending on the coordination study).

g) The integrally fused circuit breaker shall be capable of interrupting available short circuit currents up to 200,000 RMS symmetrical amperes at voltage up to 600 VAC.
h) Ratings, clearances and performance of the integrally fused circuit breaker shall be in accordance with applicable standards of NEMA, IEEE and ASA.

2. Switch and fuse feeder tap:
   a. Fusible Switches: Quick-make, quick-break type with rejection clips for use with Class "R" fuses. Switches shall be removable from front of equipment without disturbing adjacent units or equipment bus structure.
   b. Fuses shall be time delay current limiting types, UL Class RK-1 for motor circuits unless otherwise indicated on the drawings. Provide one spare set of fuses of each size and type in each switchboard.
   c. Provide auxiliary contacts on switch for remote status (on-off) signaling and monitoring.

2.04 MOTOR STARTERS - 50/60Hz AC INDUCTION ELECTRIC MOTORS

A. General

1. Motor starters shall be horsepower rated for the motor connected to the starter, air insulated, with NEMA rating.
2. Motor starter coils and controls shall be designed to operate on the control voltage indicated on the control diagrams and specifications. The motor starters shall reliably pick-up and seal-in at 80% through 110% of their coil control voltage.
3. Under voltage release for motor starter coil circuit shall automatically drop motor starter off the line when the line voltage drops below normal operating voltage. Under voltage release shall be field adjustable 80% to 95% of nominal voltage with field adjustable dropout delay 0.1 to 3 seconds minimum for starters larger than NEMA size 1. The under voltage release shall reset automatically when line voltage level returns too normal. The reset time delay shall be a 0.1 to 60-second field adjustable time range for starters larger than NEMA size 1.
4. Each motor starter control circuit shall be independently fused.
5. Three phase motor starters controlling three phase motors, five (5) horsepower and larger shall provide integral motor single phasing protection. The starter shall automatically "open", turn off electrical power to the connected motor in the event of the loss of one or more circuit phases, lock out and require manual resetting of the single phase protection to restart the magnetic motor starter. Provide single-phase annunciator. Provide adjustable time delay, minimum range 0.1 to 3 seconds for initiating single phase shut down.
6. Starter units shall be equipped with individual control power transformers (grounded type) with secondary and primary control power fuses. One secondary lead shall be grounded in the unit.
   a. The unit disconnect shall be equipped with a normally open contact to isolate the control circuit from the source when the controller disconnect is open.
   b. The control power transformer VA load rating shall include the motor starter, additional internal and external control devices connected to the motor starter, to insure control power voltage drop does not exceed 5% of nominal rating.
7. Starter units shall be equipped with three (3) motor overload elements, one for each phase, with automatic lockout, external overload indicating flag/pilot light and manual reset external push-button. Trip rating characteristics of the overload elements shall be as recommended by motor manufacturer.
   a. Motor overload protection relays shall be bi-metal (non-melting) “heater-element” type or solid-state type, for motor starters NEMA size 1 and smaller.
   b. Motor overload protection relays for motor starters larger than NEMA size 1 shall be solid-state type.
8. Pilot light indicators shall be provided with "Push-to-Test" feature. Provide a capacitor in parallel with the starters stop-start control relay circuit, to permit the motor starter control circuit to “drop-out” (turn-off) and prevent “capacitive-holding” (capacitive coupling) on control circuits with “long” (excessive distance) control circuit wiring.

9. Each starter shall be equipped with a minimum of one (1) normally open and one (1) normally closed auxiliary spare contacts. Provide additional auxiliary control contacts for interlocking with system control circuits as indicated on the drawings and specifications. Auxiliary contacts shall be field convertible for normally open or normally closed operation. Contacts shall be rated not less than 10 amps at 120 volt 60Hz, AC, but in no case shall the auxiliary contacts be rated for less ampere or lower voltage than the connected control circuit.
10. Motor starters larger than NEMA size 1, provide a running time meter 0 to 99999 hours minimum range, and an operations counter 0 to 9999 meter minimum operations start count range. Meters shall be field resettable with maintained memory during power outages of any length.
11. Minimum starter size shall be NEMA 1, but in no case less than indicated on the drawings or specifications.
12. Verify the exact motor connection requirements, motor locked rotor/full load current, NEMA code letter and voltage characteristics with the supplier of each motor. Motor starters shall comply with the identified requirements.
13. Each starter shall be equipped with "Hand-off-Auto" switch or stop-start push-button as required.
14. An auxiliary relay contact for remote alarm annunciation shall provide common trouble annunciation for any of the starter automatic protection systems. The alarm contact shall automatically reset when the starter is reset.
15. Provide each motor starter main "start" control relay or starter coil as applicable, with a magnetic coil auxiliary control “pilot” relay. The contacts of the auxiliary control relay shall directly control the starting, running and stopping control voltage of the motor starter main control coil circuit. The coil of the auxiliary relay shall condition and match the voltage and in rush of each motor starter to the requirements of the incoming control circuit.
16. Provide a transient surge suppressor for each motor starter coil, to limit voltage transients induced by the motor starter coil operation and to protect the motor starting circuit from voltage transients.
17. Motor starters connected to engine generator emergency power supply source (either direct connection or connection through an automatic transfer switch) shall each be provided with a field adjustable (0.1 - 180 seconds) "start" (on delay) time delay, to provide "staggered" sequenced starting of the connected motor load.

B. Full Voltage Non Reversing (Fvnr), Unless Noted Otherwise
   1. Across the line full voltage magnetic electromechanical motor starter.
   2. Provide FVNR motor starter for motor sizes through fifty (50) horsepower (241 to 600 volt) and through thirty (30) horsepower (240 volt and under) where the motor is connected to normal power utility source, unless noted otherwise on drawings.

C. Two Speed Motor Starters
   1. The two (2) speed motor starters shall be compatible with the connected motor and shall provide automatic two (2) speed control of separate high speed and low speed motor winding or consequent pole two (2) speed motors as applicable. The starters shall be constant horsepower, constant torque or variable torque as applicable for the motor connected to the starter.
   2. Low speed compelling control shall compel the motor starter to always start the motor on low speed before switching to high speed. Compelling control shall be manual switch selectable as either "in" or "out" (bypass) of the motor control circuits.

D. Reduced Voltage Non-Reversing (RVNR)
   1. General
      a. The reduced voltage starter shall reduce both motor starting current and motor starting torque.
      b. Reduced voltage starters shall be closed transition types.
      c. Provide RVNR motor starters for motors larger than thirty (30) horsepower (240 volt and below) and larger than fifty (50) horsepower (over 240 volts), reduced voltage type (Where the motor starter circuit is connected to engine generator emergency power source for motors larger than five (5) horsepower, provide each respective motor with RVNR reduced voltage motor starters).
      d. Starters shall provide field adjustable time periods for acceleration (reduced voltage) and transition (transfer to full voltage) modes, with failure to transfer lockouts and pilot light annunciators. Adjustable time range shall be 0.1 to 15 seconds.
      e. Duty cycle - NEMA rated medium duty, starters shall provide for not less than one (1) 15-second duration starter operation in each 4-minute interval for a 1-hour period, followed by a cool down rest period of 2-hours before the duty cycle is repeated. Provide automatic temperature lockout to prevent exceeding starter duty cycle.
      f. Reduced voltage non-reversing RVNR Motor starters shall be types described in the following paragraphs.
   2. Autotransformer type reduced voltage starter
      a. Auto transformers on each phase with field adjustable transformer voltage taps for 50%, 65%, and 80% motor terminal starting voltages.
      b. Magnetic electromechanical motor contactor type.

2.05 COMBINATION MOTOR STARTERS

A. General
   1. Combination motor starters shall consist of a feeder tap device, motor starter and enclosure. Voltage and amperage rating as indicated on drawings.
   2. Combination motor starter shall not be less than NEMA size 1, but in no case less than indicated on the drawings.
   3. Unit shall be self-contained floor standing, wall mounted NEMA 1 enclosures or as indicated on the drawings. Constructed, tested and listed in accordance with NEMA, ANSI and UL standards.
   4. Combination motor starters as manufactured by General Electric, Westinghouse, Square D, Cutler Hammer or equal.
   5. Provide incoming line and outgoing load terminations, size and capacity to match connections shown.

B. Construction
   1. NEMA styles metal enclosed, with full height hinged access door. 12-gauge welded frame members and 14 gauge panel members. All parts shall be removable and accessible from the front for ease of maintenance and rearrangement.
   2. Provide removable lifting points and permanent anchor mounting points on the enclosure.
   3. Hinged doors shall be mounted with removable pin hinges and secured with quarter turn indicating fasteners. A door interlock with manual defeat override shall prevent access to unit interior when the feeder tap device is in the "on" position.
   4. Each metal surface shall be phosphatizing prime rust inhibitor painted and baked enamel finish painted Manufacturer's standard color.

C. Combination Motor Starter Short Circuit Coordination Protection
   1. The combination motor starter shall be constructed and tested to comply with the following requirements.
   2. Type 1 coordination:

Under short circuit conditions the contactor/motor starter shall cause no danger to persons or installation. Continued re-use shall be permitted after service, repair or replacement of parts.

3. Type 2 coordination:
   a. Under short circuit conditions the contactor/motor starter shall cause no danger to persons or installation. Continued re-use shall be permitted without requiring any service, repair or replacement of parts.
   b. Motor starters shall also comply with International Electromechanical Committee (IEC) Type-2 short circuit protection, as recommended by the Manufacturer's published protection tables and as certified by UL.

D. Energy Efficient Motor Protection
   1. Where a combination motor starter is connected to a high efficiency motor, provide one (1) of the following modifications to the starters or circuit disconnects. The modification shall prevent unnecessary tripping from locked rotor high inrush motor starting current:
      a. Circuit breaker or MCP short circuit protection - Provide circuit breaker/MCP with adjustable magnetic current trip for high inrush motor starting current, or adjustable time delay trip for high magnetic current motor inrush damping.
      b. Switch and fuse motor short circuit protection - Provide fuses with sufficient inherent time delay to allow passage of high magnetic current inrush motor starting current.

PART 3 - EXECUTION

3.01 MOTOR CONTROL CENTER AND INDIVIDUAL COMBINATION MOTOR STARTERS

A. Install motor control equipment in accordance with manufacturer's written instructions and applicable portions of NEMA "Standards of Installations" for switchboards and motor control centers and individual motor starters.

B. Bolt motor control equipment to floor and wall where wall exists. Where units are free standing provide preformed steel channel or angle iron bracing to nearest wall or building structural member. Motor control equipment anchoring shall be designed for a 1.0 gravity lateral acceleration of the equipment. Submit structural calculation and details.

3.02 IDENTIFICATION

A. Provide a red and white bakelite nameplate with ½-inch high letters fastened to face of dead- front plate, to read: "DANGER 480 (actual volts) VOLTS, KEEP OUT, AUTHORIZED PERSONNEL ONLY".

B. Manufacturer shall stencil the panel number and name of the connected motor circuit on each device and equipment section to correspond to identification on the drawing.

C. Identification plates and numbers shall be attached with screws or twist lock fasteners. Adhesive attachment of any kind as the only method of attachment shall not be used.

3.03 SETTINGS AND ADJUSTMENTS

A. Program and set control function sequences, time delays, and protective device settings for correct system operation.

B. Test all timing, control sequences and motor rotation direction for proper operation. Correct deficiencies and retest until proper operation is confirmed.

END OF SECTION
021413/212164

SECTION 26 50 00
LIGHTING FIXTURES

PART 1 - GENERAL

1.01 SCOPE

A. Work Included:

All labor, materials, appliances, tools, equipment 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 specification sections and drawings for related work required to be included as work under Division 26.
2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. General
   1. Submit certification letter from manufacturers of Lamps and Ballasts and power supplies, (or alternately, manufacturer's published catalog data) stating/showing the specific lamp, ballast, or power supply combination comply with manufacturer recommendation and approval for the combined use, shown on the drawings.
   2. Provide complete manufacturers catalog data information for each light fixture (luminaire), ballast, lamp, materials, auxiliary equipment/devices, finishes and photometrics.

B. Performance Certification
   1. Submit manufacturer's certified lamp and ballast tests report data showing compliance with contract document.
   2. Submit manufacturer's letter of certification for each fixture type, confirming the proposed combination of specific lamp, ballast and auxiliary components for each light fixture (luminaire) type will function together correctly and perform in compliance with the requirements of the contract documents as follows:
      "The proposed lamp(s), lamp ballast(s)(where, applicable), lamp sockets and fixture have been tested as an assembly. The proposed fixture products assembly are certified by the manufacturer to function within the required temperature, lumen output, electrical characteristics and operational life described in the contract documents".

C. Light Fixture Samples
   1. If requested by the DISTRICT'S Representative, provide a sample of each fixture proposed as a substitution for a specified fixture. Sample fixture shall be complete with specified lamps, 3-wire grounding "SO" cord and plug for 120-volt 60Hz, AC plug-in operation. Sample fixtures shall be delivered to the District's Representative's office for review, the samples shall be picked up within 10-working days after review comments have been received; any samples left beyond this time will be discarded by the District's Representative. Decision of District's Representative regarding acceptability of any lighting fixture is final.

1.03 QUALITY ASSURANCE (ADDITIONAL REQUIREMENTS)

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 Document 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. UL – Underwriters' Laboratory:
      a. UL – 1572: HID Lighting Fixtures

b. UL – 1570: Fluorescent Lighting Fixtures
c. UL – 1029: HID Ballast
d. UL – 935: Fluorescent Lamp Ballast
e. UL – 542: Lamp Holders, Starters, and Starter Holders
f. UL – 8750: Light Emitting Diode – LED
and 1598C: Equipment for use in Lighting Products and Replacements

2. NEMA – National Electrical Manufactures Association:
   a. NEMA – LE4: Recessed Luminaries Ceiling Compatibility
   b. NEMA – SSL #1, #3 and #6: Electronic Drivers for LED; LED and Incandescent Lamp Replacement
   c. NEMA – LSD #44, #45, #49 and #51: SSL-solid state lighting
3. United States Federal Government:
   a. FCC – Part 18: EMI and RFI emissions limitations.
   b. EPA: Energy conservation publications and waste disposal regulations.
4. ETL and C.B.M. certified and approved.
5. Electrical installation standards, National Electrical Contractors' Association:
   a. NEIS/NECA and IESNA – 500 Recommended Practice for: Installing indoor Commercial Lighting Systems.
   b. NEIS/NECA and IESNA – 501: Recommended Practice for installing Exterior Lighting Systems
   c. NEIS/NECA and IESNA - 502: Recommended Practice for installing Industrial Lighting Systems.
6. Illuminating Engineering Society – IES (IESNA):
   a. IES – LM41: Photometric and Reporting.
   b. IES – 587: Transient Surge Protection.
   c. IES – LM79: Solid State Lighting (SSL) Testing and Measurement.
   d. IES – LM80: Testing for Lifetime of LED.
7. ANSI-American National Standards Institute:
   a. ANSI – C81
   b. ANSI – C82
   c. ANSI – C62.41: Transient Withstand
   d. ANSI – C78: Lamps
8. State California Code of Regulations - Title-24: Energy Code
9. DALI – Digital Addressable Lighting Interface, shall comply with latest versions of IEC-609929 and NEMA-243. See Specification Section 16575 "DALI Lighting Controls" for additional requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Complete Fixture
   1. Provide light fixtures complete including lamps, ballasts, lamp holders sockets, housings, ceiling and wall trim "rings" for each ceiling type, mounting and adapter support brackets, diffusers/lenses and outlet boxes.
   2. Include an allowance of $300.00 to provide a light fixture for each lighting fixture outlet shown on drawings without a fixture type designation.

B. Specific Fixture Requirements and Fixture Schedule Information
   1. The catalog numbers included in the description of the various types of lighting fixtures shall be considered to establish the type or class of the fixture with a particular manufacturer only. The fixture length, number of lamps and lamp types, component materials, accessories, mounting type, ceiling, wall and install adapters, operation voltage, and all other components required to fulfill the total description of the fixture based on all drawing information, branch circuits, voltages, specification information, and shall be included in the contract requirements regardless of whether or not the catalog number specifically includes these components

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2. Lighting fixtures shall be the types as indicated in fixture schedule on the drawings and as described in the specifications.
3. All fixtures of the same fixture type shall be the same manufacturer and of identical finish and appearance, unless indicated otherwise on drawings.

C. Manufacturer Certification of Operation
1. Lamps and lamp ballasts and power supplies (drivers) shall be recommended and certified by the respective manufacturer(s), to be "matched" to operate correctly together, within the published characteristics, for efficacy, lamp starting, operating life hours, lumen output, power factor, power input, operating line ampere, sound intensity, and temperature.

2.02 BALLASTS AND POWER SUPPLIES (FOR HID LAMPS AND FLUORESCENT LAMPS AND DRIVER-POWER SUPPLIES FOR LED-SOLID STATE LAMPS)

A. General
1. All ballast, power supplies, lighting fixtures assemblies and components shall be ANSI, ETL approved C.B.M. certified and UL labeled.
2. Ballasts shall provide Class "P" thermal protection.
3. Ballasts shall comply with FCC Part 18 Class-A and NEMA limits as to EMI or RFI and not interferes with normal operation of electrical or electronic data processing equipment.
4. Open circuit voltage, starting voltage, crest voltage and lamp-operating voltage shall comply with requirements of the respective manufacturer of the installed lamps.
5. Lamp ballasts, power supplies and transformers shall be for use with the specific lamps provided as part of the Contract.
6. Shall be suitable for use with automatic occupancy motion sensing type switching "on-off" control systems, with multiple "on-off" cycles per hour, on a 24-hours a day basis. Operation shall be without loss of performance in operating characteristics described in the Contract Documents.
7. Fusing
   a. Shall be independently fused on the incoming line side within the fixture compartment. b. Alternately the ballast manufacturer may install the equipment fuse inside the ballast /power supply.
   c. Provide a label next to ballast cover reading: "Ballast (Power Supply) is fused, check fuse prior to relamping". Provide an additional quantity of 10% spare fuses and deliver to District's Representative.
8. Ballast sound rating Class-A or better. Where sound-rating classification is not published, the ballast sound rating shall be the best of product manufactured. Ballasts, which are judged by the District's Representative to be excessively noisy, shall be removed and replaced at the CONTRACTOR'S expense with low noise ballasts.
9. Electronic solid-state ballasts and power supplies shall be the product of manufacturer that has been producing electronic ballasts/power supplies for a minimum of five consecutive years prior to the date of the contract.
10. Provide low temperature rated ballasts and power supplies in lighting fixtures installed outdoors; in non-heated building spaces; inside walk-in refrigerators/freezers, cold storage spaces. The minimum starting temperature rating shall be not less than zero-degrees Fahrenheit.
11. Shall be designed and supplied to operate on the incoming line voltage system circuits to which the respective light fixtures are connected.
12. Shall not contain any PCB (polychlorinated biphenyl).
13. Power factor shall be not less than 0.90, starting and operating. The input starting transient line input ampere should never exceed lamp normal operating ampere by more than 10%.
14. Ballast and power supply disconnect:
   a. Lighting fixture manufacturer factory installed and prewired inside each light fixture, for lamp-ballast or lamp-driver power supply.

b. Shall comply with UL-2459 and CEC/NEC. Shall disconnect (load-break) energized or de-energized ballast/driver from respective line voltage circuit and dimming circuit. UL-94V-0 flame retardant.
c. Hot plugable, multi-pole, insulated connectors, with strain relief and finger-safe squeeze-to-release latching function.
d. Suitable for available voltage and ampere dimming and non-dimming lamp-ballasts and lamp-power supplies.

15. Ballast and power supplies as manufactured by General Electric, Advance, Philips, Universal, Sylvania/Osram or equal.

B. Core and Coil - Non Solid-State Fluorescent Lamp Ballasts
1. Fluorescent ballasts shall be energy saving core and coil design for straight or "U" lamps, T12 and T8 series lamps.

C. Solid-State Electronic Fluorescent Lamp Ballast
1. Fluorescent ballasts shall be solid-state electronic type ANSI C82.11.
2. Ballast shall operate lamps at voltage frequency exceeding 40kHz, without visually detectable flicker, flicker index shall not exceed 3%. Shall deliver lamp manufacturers normal rated lamp life.
3. Ballast normal operations and life expectancy shall not be affected by lamp failure or sustained open circuit/short circuit.
4. Ballast shall be surge and transient protected to 6000 volts, ANSI-C62.41, Category-A.
5. Maximum total harmonic distortion (THD) created by operation on the line (input) side of the ballast shall not exceed 10%.
6. The ballast shall provide an isolated output to the lamps. Metal ballast case shall be positively grounded to the light fixture metal housing.
7. The ballast shall incorporate transient surge protection to prevent damage to the ballast due to line side transients.
8. The ballast lamp current crest factor shall be 1.7 or less (ratio of peak to RMS current).
9. The ballast factor (BF) shall be not less than the following unless indicated otherwise on the drawings.
   a. 0.87 BF for normal light output.
   b. 0.95 BF for high light output (HO) operation.
   c. 1.0 BF for dimming ballast.
10. Normal rapid start (continuous full filament voltage) Rapid Start - Rapid start ballast shall energize (preheat) the lamp cathode “heater” filament prior to establishing the lamp arc ignition, normal lamp operation shall occur within 1-second after starting. The ballast shall provide approximately 15,000-lamp start “on-off” cycles prior to lamp failure.
11. Instant start - Instant start ballast shall energize the lamp with an initial increased voltage to initiate the lamp arc discharge between the unheated (no preheat) lamp cathodes and ensure the lamps start without delay or flashing, eliminate lamp operating power required for cathode heating. Preheating the lamp cathodes shall not be performed by the ballast. The ballast shall control the lamp start “on-off” cycles to provide approximately 10,000 starts prior to lamp failure.
12. Program Start - Integrated circuit (IC) program start ballast shall energize (preheat) the lamp cathode “heater” filament for a programmed time duration prior to transition phase to lamp arc ignition and immediately de-energize the cathode after arc is established and lamp is operational. The ballast shall precisely control the cathode temperature and duration to increase lamp start “on-off” cycles prior to lamp failure to approximately 35,000 starts. The ballast shall reduce the “black-end” lamp condition resulting from frequent lamp “on-off” cycles. The Program Start ballast shall provide Automatic End of Life (EOL) lamp current shut-off, when a lamp fails.
13. DALI ballast, one lamp, two lamp, three lamp, or four lamp, dimming and switching capacity. Comply with DALI published control and communication protocol standards. Universal input line voltage operation.

D. Solid-State Electronic Metal Halide Lamp Ballast
   1. Solid-state electronic for low wattage "pulse-start" metal halide type lamp operation.
   2. Lamp current crest factor (ratio of peak to RMS current) shall not exceed 1.5.
   3. Operate lamps at a frequency of less than 200 HZ to minimize acoustic resonance inside the lamp arc tube and minimize lamp flicker.
   4. Ballast factor (BF) shall be 1.0.
   5. Automatic ballast thermal protection and automatic shutdown at end of lamp life (EOL) protection.
   6. Total harmonic distortion (THD) on the input line side shall not exceed 16%.

E. Dimming Ballasts and Lighting Control System Ballasts
   1. General
      a. The light fixture ballasts shall comply with the recommendations of the lighting control system manufacturer, as to ballast type and ballast manufacturer sources. Provide documentation with shop drawings certifying compliance with the requirements.
      b. DALI ballasts shall comply with the recommendations of the DALI lighting control system manufacturer. DALI ballast types and DALI ballast manufacturer sources shall comply with the recommendation with the shop drawings certifying compliance with these requirements and recommendations.
   2. Fluorescent lamp dimming
      a. One or multi-lamp rated dimming ballast shall be provided for fluorescent lamp dimming systems, as recommended by the lighting control system manufacturer.
   3. Lighting fixtures with DALI ballast and control, or with dimming ballast lighting and control. Provide "plug-in" connectors, for lighting control circuits, as recommended by lighting controls manufacturer. Make provisions for isolation of the control circuits from line voltage circuits inside the light fixtures.

F. Emergency Lighting
   1. Light fixtures shown connected to both normal power and external emergency power branch circuits, shall be furnished with separate lamp ballasts for the normal and emergency power circuits.
   2. The ballast(s) for the lamps connected to the external emergency branch circuit shall be in a separate wireway isolated and barriered from the ballast(s) for the lamps connected to the normal power branch circuits. The fixture shall be factory labeled "emergency" and "normal" on the respective wireways and ballasts.

G. Tandem Ballast Connections
   1. Ballasts in one (1) or three (3) lamp fluorescent fixtures, when fixture is recessed mounted and within 8-feet of each other, or if surface on pendant mounted within 1-foot of each other, shall be furnished with a tandem wiring harness connected to inboard Ballasts of master fixture, to be field connected to inboard ballast of adjacent fixture. Night-light or emergency light fixtures shall be exempt from this requirement.

H. Tabulation Ballast Performance Requirement
   1. Linear Fluorescent Instant Start Lamp Ballast Characteristics – Table #1

Lamp Characteristics			Lamp/Quan. Each Ballast	Ballast Elec. Input Max. Load			
				ANSI Input Watts		Input - VA	
Designation	NOL.	Watts		& BF	& BF	& BF	& BF
				0.87BF		0.87BF	
T12	48"	34	1	31	-	33	-
T12	48"	34	2	60	-	61	-
T12	48"	34	3	91	-	93	-
T12	48"	34	4	-	-	-	-

Lamp Characteristics			Lamp/Quan. Each Ballast	Ballast Elec. Input Max. Load			
				ANSI Input Watts		Input - VA	
Designation	NOL.	Watts		& BF	& BF	& BF	& BF
				0.87BF	1.2BF	0.87BF	1.2BF
T8	48"	32	1	32	41	34	42
T8	48"	32	2	58	77	61	78
T8	48"	32	3	85	111	86	115
T8	48"	32	4	112	-	114	-
				0.98BF		0.98BF	
T5	48"	28	1	30	-	31	-
T5	48"	28	2	60	-	61	-
T5	48"	28	3	-	-	-	-
T5	48"	28	4	-	-	-	-
				1.0BF		1.0BF	
T5-HO/PS	48"	54	1	62	-	64	-
T5-HO/PS	48"	54	2	120	-	121	-
T5-HO/PS	48"	54	3	-	-	-	-
T5-HO/PS	48"	54	4	-	-	-	-

2. Compact Fluorescent Lamp (CFL) Ballast Characteristics – Table #2

Lamp Characteristics			Lamp/Quan. Each Ballast	Ballast Elec. Input Max. Load			
				ANSI Input Watts		Input - VA	
Designation	NOL.	Watts		& BF	& BF	& BF	& BF
				0.87		0.87	
T5/CFL	22.5"	40	1	40	-	44	-
T5/CFL	22.5"	40	2	72	-	74	-
T5/CFL	22.5"	40	3	103	-	106	-
T5/CFL	22.5"	40	4	-	-	-	-
				0.90BF		0.90BF	

3. Compact Fluorescent Lamp (CFL) Ballast Characteristics – Table #2 (cont'd)

Lamp Characteristics			Lamp/Quan. Each Ballast	Ballast Elec. Input Max. Load			
				ANSI Input Watts		Input - VA	
Designation	NOL.	Watts		& BF	& BF	& BF	& BF
T5/CFL-HO	20.7"	55	1	58	-	61	-
T5/CFL-HO	20.7"	55	2	104	-	107	-
T5/CFL-HO	20.7"	55	3	-	-	-	-
T5/CFL-HO	20.7"	55	4	-	-	-	-

4. High Intensity Discharge (HID) Lamp Ballast Characteristics – Table #3

Lamp Characteristics		Ballast Maximum Electrical Input Load			
Designation	Lamp Watts	ANSI Input Watts		Input - VA	
		Core/Coil	Electronic	Core/Coil	Electronic
		Probe Start Metal Halide			
Metal Halide – MH	35/39	53	45	170	55
Metal Halide - MH	50	70	57	168	61
Metal Halide - MH	70	90	83	229	87
Metal Halide - MH	100	129	113	140	117
Metal Halide - MH	150	189	169	222	170
Metal Halide – MH	175	211	195	218	205
Metal Halide - MH	250	296	-	306	-
Metal Halide - MH	400	461	-	482	-

Lamp Characteristics		Ballast Maximum Electrical Input Load			
Designation	Lamp Watts	ANSI Input Watts		Input - VA	
		Core/Coil	Electronic	Core/Coil	Electronic
		Probe Start Metal Halide			
Metal Halide - MH	1000	1080	-	1083	-
Metal Halide - MH	1500	1615	-	1636	-
PULSE START – HID					
Metal Halide	100	-	-	-	-
Metal Halide	175	208	-	222	-
Metal Halide	200	232	-	250	-
Metal Halide	350	400	-	46	-
Metal Halide	400	452	-	471	-
Metal Halide	750	818	-	840	-
Metal Halide	1000	1080	-	1081	-
HPS	50	66	72	128	166
HPS	70	95	-	111	-
HPS	100	138	-	144	-
HPS	150	190	-	204	-
HPS	200	250	-	278	-
HPS	250	295	-	305	-
HPS	310	365	-	406	-
HPS	400	464	-	471	-
HPS	1000	1100	-	1164	-

5. Ballast table notes:
   a. ANSI Watts = Ballast input watts at 25 C (77 F) ambient; less than 1 foot per minute air flow; horizontal lamp position. Greater than 9-inch lamp to lamp spacing for fluorescent lamps; Not less than 100 hours (seasoning) on new lamp operation prior to testing; perform test reading 30 seconds after test ballast/lamp operation is initiated.
   b. BF = (Ballast factor). (Lamp lumen output of specified ballast) ÷ (lamp lumen output with test laboratory "reference test ballast"). Lamp ballast factor shall not be less than described in the Contract Documents.
   c. HO = High output rated lamps and ballasts (Note: All linear fluorescent lamps and ballasts shall be "normal" output rated, unless noted otherwise).
   d. HPS = High pressure sodium.
   e. PS = Program start rated lamps and ballasts (Note: all linear fluorescent lamps and ballasts shall be instant start rated, unless noted otherwise).

2.02 LAMPS

A. General
   1. Lamps shall be new, of wattage and type indicated. Each fixture or lighting outlet shall be supplied with the proper lamp(s).
   2. Lamps shall comply with the characteristics as described in the lamp tables below, except where indicated otherwise on the drawings.
   3. Lamps shall comply with limits on mercury and classification as non-hazardous waste as follows:
      a. Federal EPA – Toxicity Characteristics Leaching Procedures (TCLP).
      b. State of California – Total Threshold Limit Concentration (TTLC).
   4. Lamps shall be as manufactured by General Electric, Philips, Osram or Sylvania.

B. Incandescent Lamps
   1. General-purpose incandescent "A" style lamps shall not be used.

2. Reflector lamps shall be PAR-20, PAR-30 or PAR-38 as required, unless otherwise specified in fixture schedule.
3. Incandescent lamps in non-enclosed fixtures and fixtures without lens/diffuser –Not Used

C. Fluorescent Lamps
1. Linear fluorescent shall be energy saving type and bi-pin operation. Rapid-start, Program Start or instant start as indicated in the contract documents.
2. Compact fluorescent lamps.
3. Average lamp life shall not be less than the following, based on 3 hours "on" operation and 20-minute "off" for each start cycle, when matched in combination with the specific lamp ballast and with the respective light fixture, unless noted otherwise:
   a. Linear fluorescent 20,000 hours.
   b. CFL – 20,000-hours and as noted in the lamp tables.
   c. HID – as noted in the lamp tables, based on 12-hours "on" operation for each start cycle.
   d. Incandescent – as noted in the lamp tables.

D. High Intensity Discharge Lamps HID
1. Mercury vapor lamps shall be Deluxe White or Brite White Deluxe phosphor coated Bonus-Line.
2. Provide proper base up, base down, horizontal, operating configuration for the fixture and lamps being furnished.
3. HID lamps (indoor or outdoor locations).
   a. HID lamps used outdoors or in damp/wet locations shall only be used in fully enclosed, lensed fixtures.
   b. Open type fixtures with HID lamps used indoors shall only be ANSI-"TYPE-0" protected lamps and protected lamp sockets or shall only be fully enclosed, lensed fixtures.
   c. Enclosed/lensed fixtures with HID lamps, shall be rated for "ARC-TUBE Containment"
4. Lamps in non-enclosed light fixtures shall be equipped with automatic switching device to de-energize the lamp when the lamp outer glass envelope is broken.
5. High-pressure sodium lamps shall be clear unless noted otherwise on drawings.
6. Metal halide lamps shall be clear or coated as indicated on the drawings.
7. Lamp socket and lamp "burning" position of operation rating (i.e., base-up, base-down, horizontal) shall comply with the actual lighting fixture installation location.

E. Tabulation Lamp Performance Requirement
1. Linear Fluorescent Lamp Characteristics – Table #1
   20,000 Hours Average Life at 3 Hours per Start

Lamp Designation		Lamp NOL.	Lamp Watts	Initial Lumens*	Lamp CCT(K)	Lamp CRI
Diam.	Type					
T12	F40/30	48"	34	2900	3000	82
T12	F40/35	48"	34	2900	3500	82
T12	F40/41	48"	34	2900	4100	80
T12	F40/50	48"	34	2700	5000	80
T8	FO32/30	48"	32	2850	3000	75
T8	FO32/35	48"	32	2850	3500	75
T8	FO32/41	48"	32	2850	4100	75
T8	FO32/50	48"	32	2650	5000	75

2. Linear Fluorescent Lamp Characteristics – Table #1
20,000 Hours Average Life at 3 Hours per Start (cont'd)

Lamp Designation		Lamp	Lamp	Initial	Lamp	Lamp
Diam.	Type	NOL.	Watts	Lumens*	CCT(K)	CRI
T8	FO32/30/XPS	48"	32	3100	3000	85
T8	FO32/35/XPS	48"	32	3100	3500	85
T8	FO32/41/XPS	48"	32	3100	4100	85
T8	FO32/50/XPS	48"	32	2850	5000	85
T8	FO32/65/XPS	48"	32	2850	6500	85
T5	FP28/30	48"	28	2610 2900	3000	82
T5	FP28/35	48"	28	2610 2900	3500	82
T5	FP28/41	48"	28	2610 2900	4100	82
T5	FP28/50	48"	28		5000	
High Output						
T5	FP54/30/HO	48"	54	4400 5000	3000	82
T5	FP54/35/HO	48"	54	4400 5000	3500	82
T5	FP54/41/HO	48"	54	4400 5000	4100	82
T5	FP51/50/HO	48"	54		5000	

3. Compact Fluorescent Lamp (CFL) Characteristics – Table #2

Lamp Designation		Lamp	Lamp	Initial	Lamp	Lamp
Diam.	Type	NOL.	Watts	Lumens*	CCT(K)	CRI
a. Twin Tube/4-PIN/2G11						
T5/CFL	F40BX/30	22.5"	40	3150	3000	82
T5/CFL	F40BX/35	22.5"	40	3150	3500	82
T5/CFL	F40BX/41	22.5"	40	3150	4100	82
T5/CFL	F40BX/50	22.5"	40	2900	5000	80
b. High Output, Twin Tube/4-PIN/2G11 (12,000-Ave. Life/Hrs)						
T5/CFL	F55BX/30/HO	20.7"	55	4800	3000	82
T5/CFL	F55BX/35/HO	20.7"	55	4800	3500	82
T5/CFL	F55BX/41/HO	20.7"	55	4800	4100	82
T5/CFL	F55BX/50/HO	20.7"	55	4800	5000	80

4. High Intensity Discharge (HID) Lamp Characteristics – Table #3

Lamp Designation		Average	Lamp	Initial	Lamp	Lamp
Identification	Type	Life/Hrs	Watts	Lumens*	CCT(K)	CRI
a. Vertical Lamp 15-Degree, for Base-Up and Base-Down Positions, Mogul Base and Socket						
Metal Halide	MH175/HO	10,000	175	13,000	3200	70
Metal Halide	MH250/HO	10,000	250	20,500	3900	70
Metal Halide	MH400/HO	20,000	400	40,000	3700	70
Metal Halide	MH1000/HO	12,000	1000	115,000	3800	65
Metal Halide	MH1500/HO	3,000	1,500	167,000	4000	70
b. Horizontal Lamp Position, Mogul Base and Socket						

5. High Intensity Discharge (HID) Lamp Characteristics – Table #3 (cont'd)

Lamp Designation		Average	Lamp	Initial	Lamp	Lamp
Identification	Type	Life/Hrs	Watts	Lumens*	CCT(K)	CRI
Metal Halide	MH175/HO	10,000	175	15,000	3500	70
Metal Halide	MH250/HO	15,000	250	19,700	3600	70
Metal Halide	MH400/HO	22,000	400	36,800	3900	70
Metal Halide	MH1000/HO	9,000	1000	91,800	3400	70
Metal Halide	MH1500/HO	3,000	1,500	153,000	4000	70
c. Low Wattage Lamps, Universal Mounting Position, Medium Base and Socket						
Metal Halide	MH100/HO	15,000	100	9,000	3200	70
Metal Halide	MH100/XP	15,000	100	8,100	4000	75
Metal Halide	MH70/HO	12,000	70	5,500	3200	70
Metal Halide	MH70/XP	12,000	70	4,700	4000	75
Metal Halide	MH50/HO	5,000	50	3,900	3200	70
Metal Halide	MH50/XP	5,000	50	3,100	4000	75
d. Pulse Start (Vertical Base-UP Only, 15-Degress, Operation), Mogul Base and Socket						
Metal Halide	MHP175	15,000	175	17,500	4000	75
Metal Halide	MHP200	-	200	-	-	-
Metal Halide	MHP250	20,000	250	23,000	3900	65
Metal Halide	MHP350	20,000	350	37,000	3900	65
Metal Halide	MHP400	20,000	400	42,000	4000	75
Metal Halide	MHP750	16,000	750	80,000	4000	65
Metal Halide	MHP1000	15,000	1,000	120,000	3800	65

6. High Intensity Discharge (HID) Lamp Characteristics – Table #3 (cont'd)

Lamp Designation		Average Life/Hrs	Lamp Watts	Initial Lumens*	Lamp CCT(K)	Lamp CRI
Identification	Type					
e. High Pressure Sodium, Universal Mounting Position, Mogul Base and Socket						
HPS	HPS50	24,000	50	4,000	1900	22
HPS	HPS70	24,000	70	6,400	1900	22
HPS	HPS100	24,000	100	9,500	2000	22
HPS	HPS150	24,000	150	15,000	2000	22
HPS	HPS200	24,000	200	22,000	2100	22
HPS	HPS250	24,000	250	28,000	2100	22
HPS	HPS310	24,000	310	37,000	2100	22
HPS	HPS400	24,000	400	51,000	2100	22
HPS	HPS1000	24,000	1000	140,000	2100	22
f. High Pressure Sodium, Color Improved, Mogul Base and Socket						
HPS	HPS/70/DX	15,000	70	4,400	2200	60
HPS	HPS100/DX	15,000	100	7,300	2200	60
HPS	HPS150/DX	15,000	150	10,500	2200	65
HPS	HPS250/DX	15,000	250	22,500	2200	65
HPS	HPS400/DX	15,000	400	37,400	2200	70
g. High Pressure Sodium, Color Improved, Medium Base and Socket						
HPS	HPS50/DXX	10,000	50	2,000	2700	85
HPS	HPS100/ DXX	10,000	100	4,170	2700	85

7. Incandescent Lamp Characteristics – Table #4

Lamp Designation		Average Life/Hrs	Lamp Watts	Initial Lumens*	Beam Angle	NOL
Identification	Type					
a. Tungsten Halogen Medium Base and Socket, Mid Break "A" Lamps, 120 volt – AC						
Halogen	TH/A19/50	3,000	50	860	-	4.4"
Halogen	TH/A19/75	3,000	75	1,300	-	4.4"
Halogen	TH/A19/100	3,000	100	1,800	-	4.4"
b. Tungsten Halogen Medium Base and Socket – PAR, 120 volt – AC						
Halogen	PAR16/60/SP	2,000	60	650	10	2.9"
Halogen	PAR16/60/M	2,000	60	650	30	2.9"

Halogen	PAR16/75/SP	2,000	75	900	10	2.9"
Halogen	PAR16/75/M	2,000	75	900	30	2.9"
Halogen	PAR38/120/SP	3,000	120	1,800	10	5.4"
Halogen	PAR38/120/M	3,000	120	1,800	25	5.4"
Halogen	PAR38/120/FL	3,000	120	1,800	55	5.4"

8. Incandescent Lamp Characteristics – Table #4 (cont'd)

Lamp Designation		Average Life/Hrs	Lamp Watts	Initial Lumens*	Beam Angle	NOL
Identification	Type					
c. Tungsten Halogen Two Pin Base & Socket – Clear Glass Lamp with Protective Lens for Use in "Open" Non-Enclosed Fixture Lamp, 12 volt AC, 3000 K, Non-Dichroic Reflector						
				CBCP		
Halogen	MR16/35/SP	4,000	35	7,500	10	1.9"
Halogen	MR16/35/M	4,000	35	2,900	25	1.9"
Halogen	MR16/35/FL	4,000	35	800	40	1.9"
Halogen	MR16/50/SP	4,000	50	9,500	10	1.9"
Halogen	MR16/50/M	4,000	50	2,800	25	1.9"
Halogen	MR16/50/FL	4,000	50	1,800	40	1.9"

Lamp Table Notes:

1. Fluorescent lamp lumen output listed in the tables above are based on lamp ballast, solid-state electronic ballasts, operating at 40kHz or greater.
2. Definition of terms, typical for all lamp schedules:
   a. Average Life/Hrs. = Lamp expected average operating hours when 50% of lamps have failed.
   b. Beam angle = The angle in degrees for the light dispersion, "narrowspot" (SP), "medium" (M), or "wide flood" (FL).
   c. CCT(K) = Lamp operating rated color temperature, chromaticity - Kelvin scale.
   d. CRI = Lamp minimum Color Rendering Index.
   e. CBCP = Center beam candlepower.
   f. Diam. = Nominal lamp diameter,
   g. *Initial Lumens, Lumen output after 100hrs. lamp operation to condition the lamps using a laboratory standardized ballast. 25 degrees centigrade (C) ambient operating temperature for fluorescent lamp 30 degrees centigrade (C) for HID lamp * Two (2) different lamp lumen outputs are listed for T5 linear fluorescent lamps, the 1st is at 25ºC = ambient the 2nd is at 35ºC ambient.
   h. NOL = Nominal length of lamp.
   i. Watts = Rated lamp watts, not including ballast at 25ºC ambient
   j. See ballast table notes for additional definition of terms

2.03 LIGHT FIXTURES (LUMINAIRES)

A. General

1. Lighting fixtures shall have all parts, ballasts, sockets, support attachments, trim flanges and fittings necessary to complete and properly install the fixture at the indicated installation locations. All fixtures shall be provided with lamps of size and type specified.
2. Ceiling and/or wall surface mounted lighting fixtures shall not have any exposed chase nipples or conduit knockouts visible to view within fixture housing. Lighting fixtures mounted in continuous rows shall have chase nipples or conduit knockouts between

lighting fixture housing, but shall not have visible chase nipples/conduit knockouts on the visible ends of the continuous row of lighting fixtures.

3. Where fixture color is indicated to be selected by the ARCHITECT and/or District's Representative, provide two (2) color chip samples for each color for review.
4. Recessed fixtures with attached junction box shall be provided with a junction box permanently attached to the plaster ring so that the junction box is accessible through the fixture opening when the fixture is removed. Connection between fixture and pull box shall be flexible metal conduit with not less than 16AWG "AF" or "CF" type fixture rated copper wires, high temperature wire insulation for not less than 600 volts AC. The flexible conduit shall be sufficient length, so that when the fixture is removed, the pullbox is readily accessible.
5. Recessed fixtures shall be Underwriters' Laboratory approved for recessed installation with plaster frame and attached pull box. Lamp enclosure, reflectors and finish wiring shall not be installed until plastering is completed. Exposed finish trim shall not be installed until finish painting of the adjacent surface is completed.
6. The fixture shall bear Underwriters' Laboratory label of approval for the wattage and installation indicated.
7. Light fixtures installed outdoors, in damp or wet locations shall be UL labeled for said location as "damp-location" and "wet-location" for the respective installation location.
8. Fixtures in contact with thermal/building insulation shall be UL listed and rated for direct contact installation in thermal insulation systems.
9. Lamp auxiliary support brackets shall be heat-resistant, non-dielectric. Alternatively, metal auxiliary lamp support brackets shall be electrically isolated from the fixture, to prevent glass decomposition.
10. Lighting fixtures installed in masonry and/or concrete construction. The fixture housing shall be rated for "concrete-pour" installation location.
11. Provide a permanent label inside each light fixture stating the following relamping information. Not less than 0.125-inch high black alphanumeric characters on white background.

"Replacement lamp(s) installed in this light fixture _ must comply with the following criteria:

**: CRI*	**: Lamp Watts*
**: CCT-K*	**: Lamp Lumens*

Only lamp rated * type lamp ballast shall be installed in this fixture."

*Insert the value required for the specific lamp required by the Contract Documents for each light fixture.

B. Lens and Diffusers
1. Acrylic plastic or Plexiglas for the light fixture diffusers or fixtures lenses, shall be 100% virgin material.
2. Thickness of not less than 0.125-inch, as measured at the "THINIST" portion on the diffuser or lens. However, thickness shall be increased to sufficient construction and camber to prevent the lens and diffusers from having any noticeable sag over the entire normal life of the installation.
3. Diffusers shall be formed from cast sheet by a vacuum and/or pressure technique.
4. Lighting fixtures containing lamps with dichroic reflectors and light fixtures with non-dichroic lens/diffuser shall be rated for high temperature lamp operations resulting from lamp heat redirected (reflected) back into the fixture.

C. Fixture/Luminaire Internal Wiring
1. Provide wiring between fluorescent lamp holders and associated operating and starting equipment. Provide ballasts/transformers inside lighting fixture.

2. Where there are two (2) or more fluorescent lamps in a single luminaire, and multiple level intensity control is indicted on specifications or drawings, multiple-lamp ballasts shall be used to the greatest extent possible and the following tandem wiring configurations shall apply:
   a. If "inboard-outboard" wiring or multi-intensity light switching controls are specified for (odd-quantity) multi-lamp luminaires, then the two (2) outboard lamps shall be connected to a single 2-lamp ballast within each luminaire. The inboard lamps of two adjacent luminaires shall be tandem wired, that is, connected to a 2-lamp ballast within one (1) of the luminaires.
   b. A 1-lamp ballast may be used if a luminaire with ballast is separated by more than 10-feet from any other same type luminaire with a ballast, or if the nearest luminaire is on another control circuit. Otherwise, a lamp in one (1) luminaire shall be tandem wired, that is, connected to a multi-lamp ballast in another luminaire.
3. Wire insulation for ballast/lamps employing igniters, shall be rated and UL listed for the igniter pulse voltage.
4. Light fixture internal lamp sockets; installation of lamp sockets and ballasts; grounding of lamp sockets and ballasts; and wiring connections, shall all comply with the recommendations of ballast manufacturer and lighting control system manufacturer.

D. La ∩p holders (Sockets) and Supports
1. Provide fluorescent luminaire lamp sockets that are white, constructed of high temperature heat-resistant plastic or ceramic/porcelain.
2. When electronic solid-state ballasts are provided, fluorescent lamp sockets for 4-feet-0-inches lamps shall be of the "knife edge" type. The lamp sockets providing the tightest electrical connection shall be furnished.
3. Lamp supports shall be used as recommended by lamp manufacturer.
4. Rigidly and securely attach lamp holder to the luminaire enclosure.
5. Provide lamp holders and sockets suitable for specified lamps, and position the lamps in optically correct spacing and relationship to lenses, reflectors, filters, and baffles.
6. Lamp holder location shall provide properly located starting aid, as specified by the lamp manufacturer.
7. Lamp sockets in fixtures shall be compatible with the respective specified lamp(s), as recommended by the lamp manufacturer and shall provide specified lamp operational performance.
8. Provide horizontal position (± 15-degree) lamp and lamp socket to automatically ensure lamp position, for lamps requiring horizontal only operation lamps, to ensure correct horizontal lamp install position.
9. Lamp sockets shall be rated for not less than actual volts of the igniter starting of the lamp.

E. Enclosed and Non-Enclosed HID Fixture Operation
1. HID light fixture shall be rated to contain hot lamp fragments (up to 1100 C) resulting from and HID lamp that may shatter (rupture) while operating.
2. HID lens/diffuser shall be rated to filter control short wave ultra violet (UV) from the HID lamp in the event the HID lamp shatters (ruptures). Where the lens/diffuser does not provide UV filter control, provide automatic "cutoff" operation in the light fixture as described below. Enclosed fixtures shall comply with UL-1572.
3. HID lamps, installed in non-enclosed light fixtures or installed in light fixtures not rated to contain hot lamp fragments, the lamp shall be rated for "open" fixture operation. The fixture shall provide automatic "cutoff" of electrical power to the lamp in the event the lamp(s) shatter/rupture.

F. HID Quartz-Restrike (Emergency Egress Lighting Single Circuit Operation)
1. Provide incandescent tungsten/quartz additional lamp and socket in each high intensity discharge (HID) lighting fixture shown connected to emergency electric power source. Provide automatic Quartz-Restrike control system inside each respective HID lighting fixture shown connected to emergency electric power source. Factory assembled by

lighting fixture manufacturer. Typical for emergency egress lighting HID fixtures, unless specifically noted to “omit-quartz-restrike” on the drawings. As manufactured by Thomas Research Products – ESP120/ESP125/MC1 series; Venture Lighting – ETN/MHI/PS series.

2. HID lighting fixtures with “Quartz-Restrike” control system shall provide automatic on/off control of the HID-lamp/ballast and separate independent incandescent tungsten/quartz lamp and lamp socket. The system shall operate with both "cold-start" and "hot-start" of HID lamps. The system shall operate with both on/off switching circuits and constant "on" circuits. The control system shall automatically maintain emergency egress illumination on emergency electric source.
3. The quartz-restrike control unit shall monitor both the normal source input electric power and emergency source input electric power. Upon failure of the normal source and initialization of the emergency source, the control unit shall automatically illuminate the internal incandescent lamp from the emergency power source.
4. The control unit shall simultaneously turn on (illuminate) both the incandescent source and HID sources when electrical power source supply to the HID fixtures power source is initially present. After HID lamp initial "cold-strike" or “hot-restrike” has occurred and the HID lamp has reached approximately 50 to 70% normal lumen output, the control unit shall automatically “turn-off” the incandescent lamp source and allow the HID lamp to complete return to full 100% lumen output and operate continually, without the incandescent lamp being illuminated.
5. Provide HID lighting fixtures containing quartz-restrike controls with multi-voltage ballast windings to allow taping separate HID lamp/ballast voltage and quartz-restrike lamp voltage from a common ballast. The 120 volt electric circuit power voltage source to operate the 120 volt incandescent lamp shall “tap” from the HID ballast. Provide HID lamp ballast with multi-tap “winding” voltage output to operate both the 120 volt incandescent lamp, while maintaining HID lamp/ballast operation at the branch circuit nominal input line voltage.
6. The quartz-restrike lamp shall be positioned inside the light fixture to maximize and direct incandescent lamp light-distribution to the floor area. The incandescent lamp shall not interfere or cause shadows from the HID lamp source.

2.04 SOLID STATE LIGHTING (SSL), LIGHT EMITTING DIODES (LED) LAMPS, POWER SUPPLIES, AND LIGHT FIXTURES (ADDITIONAL REQUIREMENTS)

A. General
1. Solid State LED light source (lamps), related control equipment (driver-power supply), and luminaire (light fixture) optics for light output distribution.
2. Shall comply with the US-DOE Energy Star Program for SSL-LED. Submit documentation with Shop Drawings.
3. Shall comply with the latest revision IESNA LM-79 and LM-80. Submit documentation with Shop Drawings.
4. SSL chromaticity shall comply with latest revision NEMA and ANSI – C78.377. Submit documentation with Shop Drawings.
5. Submit with Shop Drawings two (2) samples of each light fixture type employing SSL, with prewired 120 volt, 60Hz AC “SO” cord and plug-in cap.

B. LED Lamps
1. Lamp lumen output and overall efficiency shall be based on the LED lamps installed in specified fixture and ambient operating temperature.
2. Lamp Color Rendition Index (CRI) shall equal or exceed CRI – 80, unless noted otherwise on drawings.
3. Lamp color output shall be 4000-degree K (100K), unless noted otherwise on drawings.
4. CRI and lamp color temperature shall be same for all light fixtures of the same fixture type.

C. LED Power Supply (driver)
   1. Combination of power supply and SSL – lamp shall be tested and certified by respective manufacturers for performance and proper operation.
   2. Provide dimming type driver where indicated on drawings. Driver and dimming equipment shall be tested and certified by respective manufactures for performance and proper operation.

D. Self contained LED lamp and driver, integral “Screw-Base” and/or “Pin-Connect”, replacement assembly for incandescent lamps.
   1. Shall be dimmable. Dimmer and lamp shall be certified by respective manufacturers for compatible correct operation with each other.
   2. Optical system and operating temperature thermal performance shall be compatible with light fixture.
   3. Comply with latest revisions of NEMA LSD-49 and SSL-6.

2.05 EMERGENCY BALLAST LIGHTING AND EMERGENCY DRIVER LIGHTING

A. General
   1. Self-contained emergency ballast and power supply (driver) containing batteries, battery charger, solid-state electronic control and lamp/ballast/driver operation, contained within a metal case, red finish case color.
   2. UL – 924, listed Emergency Lighting and Power Equipment, for installation inside and/or attached to lighting fixtures.
   3. The emergency battery supply unit(s) shall be provided inside each respective emergency light fixture by the fixture manufacturer.
   4. Normal operating temperature range from 0-degrees Centigrade up to operating ambient temperature inside respective lighting fixture, but not less than 50-degress Centigrade.
   5. Provide a permanent label inside each emergency light fixture stating as follows, not less than 0.125-inch high black alphanumeric characters on a white background:
      "Warning – this fixture provides more than one electric power source. Disconnect both normal and emergency sources including battery sources prior to opening fixture. Written permanent records documenting regular (every 30 days) emergency lighting function testing results shall be kept on file by the DISTRICT."
   6. UL and manufacturer rated to supply the lamp and ballast/driver (power-supply) combination occurring in the respective light fixture, both dimming-type and non-dimming type light fixtures.
   7. DALI ballasts shall be types as recommended by the DALI Lighting Control System manufacturers for compatibility with the lighting control system and with the emergency ballast lighting system. The emergency ballast lighting system control system shall be compatible with the DALI lighting control system.
   8. As manufactured by Bodine Inc. or IOTA-Engineering Inc.

B. Operation
   1. Emergency mode
      When external AC electrical power fails, the emergency unit shall immediately and automatically switch to emergency mode. Maintain emergency lamp(s) illumination, while operating from the internal battery/electronics during the power failure for not less than 90-minutes continuous duration.
   2. Normal Mode
      When AC electrical power is restored, automatically switch lamp(s) operation to external AC operation and begin battery-charging mode.
   3. Battery Recharge Mode
      The battery charger shall automatically fully recharge discharged batteries in less than 24-hours, and prevent overcharging of the batteries, while maintaining a "float-charge" on the batteries.

4. The emergency battery unit shall operate not less than 2-lamps in multi-lamp light fixtures and 1-lamp in single lamp light fixtures. When operating in emergency mode and battery power, the lamp lumen output of each lamp shall be not less than 40% of the lamp normal full lumen output rating of the lamp operation on normal power. The lamp-lumen output shall be 100% of the lamp normal full lumen output rating when operating in normal mode.
5. The emergency ballast shall provide cold-strike start and hot-restrike operation of the fixture lamp(s).
6. Periodic automatic, internal self-test, simulating normal power loss and actual operation of emergency lamps on internal battery power. Auto self-test shall occur not more than 30-day intervals. Audible and visual trouble alarm display, with manual alarm reset /silence, for problems identified by autotest functions.

C. Electrical Characteristics
1. Emergency equipment shall operate on the same input AC voltage as the normally "hot" branch circuit supplying the respective light fixture. Maximum line input load shall not exceed 15% more than normal fixture electrical load.
2. The emergency equipment shall be compatible for correct operation with the specific lamp/ ballast/driver combination contained in the respective light fixture.
3. The emergency equipment shall be compatible with switched (on-off), non-switched (continuously on) and dimmer controlled lighting fixtures/circuits.

D. Components
1. Sealed nickel cadmium batteries, maintenance-free, rated for continuous operation in high ambient temperature, with 7 to 10 year operational life expectancy.
2. When standing on the floor below the fixture the emergency ballast test/monitor control panel shall be visible and readily accessible when the fixture is installed. The control panel shall provide:
   a. Charging indicator visual annunciator to display the charger and battery status.
   b. Momentary test switch/pushbutton to manually simulate power failure test.

2.06 LIGHTING STANDARDS (SUPPORT POLES, POLE MOUNTED LIGHTING FIXTURES AND LUMINAIRES)

A. General
1. Lighting poles, pole bases, pole arms, lighting fixtures (luminaires), supports with all lighting pole attachments and anchors shall be designed and constructed to withstand not less than 100 mile per hour steady horizontal wind loading and 130 mile per hour horizontal wind gust loading, without any damage to the lighting standards.
2. Provide tamper-resistant "hand-hole" and cover on the pole, for access into wiring terminations inside the pole. Provide ground "lug" attachment for equipment bond conductor.
3. Provide factory applied weather protective base undercoat and final finish on all exposed and internal components. Color as indicated or as selected by District's Representative.

B. Base Plate
1. Provide a base plate at the bottom of each pole to attach and secure the pole to the pole anchor bolts. The base plate shall be permanently attached to the bottom of the pole.

C. Anchors
1. Anchor bolts shall be threaded the entire bolt length, not less than four (4) bolts for each pole equally spaced around the pole base. Provide a minimum of two (2) threaded nuts for each anchor bolt. Install a nut on the top and bottom sides of each base plate anchor bolt location. Not less than four (4) threads shall be exposed after pole is installed and leveled.

PART 3 - EXECUTION

3.01 LIGHT FIXTURE INSTALLATION

A. General
   1. The CONTRACTOR shall verify actual ceiling and wall construction types as defined on the Architectural drawings and furnish all lighting fixtures with the correct mounting devices, trim rings, brackets whether or not such variations are indicated by fixture catalog number. The CONTRACTOR shall verify depth of all recessed lighting fixtures with Architectural drawings prior to ordering fixtures. Any discrepancies that would cause recessed lighting fixtures not to fit into ceiling shall be reported to the District's Representative prior to release of order to the supplier of the fixtures.
   2. On acoustical tile ceilings, fixture outlets shall be accurately located in the center, at the intersection of the four (4) corners or at the center of the joints of two tiles.
   3. The CONTRACTOR shall aim the exterior adjustable lighting fixtures after dark in the presence of, and at a time convenient to the District's Representative.
   4. Fixtures shall be ordered and furnished to operate correctly on the branch circuit voltage connected to the respective fixture as shown on the site plan and floor plan electrical drawings. The voltages shown on the fixture schedule are for generic fixture information only.
   5. Install and connect lighting fixtures to the circuits and control sequences indicated on the drawings and to comply with respective manufacturer's instructions/recommendations.
   6. Lighting fixtures in building interstitial spaces, in mechanical plumbing and electrical spaces /rooms, are shown in their approximate locations. Do not install lighting outlets or light fixtures until the mechanical, plumbing and electrical equipment/pipes/ductwork are installed; then adjust and install lighting in revised clear (non-interfering) locations to provide best even-illumination. Coordinate the locations with all other trades prior to lighting installation.
   7. Provide conduit and DALI Loop (Bus) communications lighting control network circuit connections, to each light fixture with DALI ballasts.

B. Lighting fixtures installed in ceiling support grids - suspended lay-in "T-bar" and concealed spline ceilings.
   1. Provide two (2) seismic clips at opposite ends of each recessed light fixture, the clip shall connect to the ceiling grid main runners and the light fixture. The light fixture with seismic clips and ceiling grid runner connections shall resist a horizontal seismic force equal to the total weight of the light fixture assembly.
   2. Each light fixture weighing 40-pounds or less and where the respective ceiling grid system is "heavy duty" type, shall be suspended directly from the ceiling grid or shall be suspended independent of the ceiling grid support system as approved by the AHJ. Each light fixture weighing more than 40-pounds or where the ceiling grid system is not a "heavy duty" type shall be supported independent of the ceiling grid and independent of ceiling grid support system.
   3. Each light fixture supported independent of the ceiling grid system shall be supported with a minimum of four taut independent support wires, one wire at each fixture corner.
   4. Each light fixture supported directly from the ceiling grid or ceiling grid support system shall be additionally connected with a minimum of two (2) independent slack safety support wires. One (1) wire at each opposite diagonal fixture corner. Each 3-feet by 3-feet and larger light fixture shall be supported in the same manner, except provide a minimum of four (4) independent slack safety wires, one at each fixture corner.
   5. Light fixtures surface mounted to a suspended ceiling shall be installed with a 1½-inch steel – "C" channel which spans across and above a minimum of two (2) parallel main ceiling grid "runners" and concealed above the ceiling. Each channel or angle member shall be provided with a minimum of two (2) threaded studs for attaching to the fixture housing through the lay-in ceiling tile. Two (2) steel "C" channel members shall be installed for each 4-foot (or smaller) fixture. Install the channels within 6-inches of each end of the light

fixture to span a minimum of two (2) ceiling grid parallel main runners. Provide two (2) seismic clips connecting the ceiling grid main runners to each steel – "C" channel. Provide a not less than two (2) taut independent support wires connecting to each channel. Bolt the light fixtures to the threaded studs on the channels or angles, to support the light fixture tight to the ceiling surface.

C. Fixture Supports
   1. The support wires for light fixture support shall be 12-gauge steel (minimum). The wires including their building and light fixture attachments shall provide support capacity of not less than four (4) times the weight of the light fixture assembly. Provide additional light fixture support wires and building anchors to meet these requirements, as part of the contract. The support wires shall be anchored to the building structural elements above the ceiling.
   2. Pendant mounting fixtures shall be supplied with swivel hangers. Fixtures shall swing in any direction a minimum of 45 degrees of gravity, position. Fixtures shall have special stem lengths to give the mounting height indicated on the drawings. Stem to be single continuous piece without coupling, and to be finished the same color as the canopy and the fixture, unless otherwise noted. The CONTRACTOR shall check all lock nuts and set screws to rigidly secure the swivel socket to the stem, and the stem to the outlet box. Fixtures shall be plumb and vertical. Where obstructions occur restricting 45-degrees free-swing of fixtures, the fixtures shall be "guy" wired to prevent fixtures from striking obstructions. The District's Representative shall approve method of guying. Swinging fixtures shall have an additional safety hanger cable attached to the structure and the fixture at each support, with the capacity of supporting four times the vertical weight of the light fixture assembly.
   3. Suspended fixtures weighing in excess of 40-pounds shall be supported independently of the fixture outlet box. Provide "air craft" (minimum 12 gauge) steel hanger cable for suspended fixtures route cable concealed or in pendant where possible. Each cable attachments shall support four times the weight of the fixture assembly. Securely attach the cable to the building structure.
   4. Surface mounted fixtures installed on drywall or plaster ceilings and weighing less than 40-pounds may be supported from outlet box. Provide structural supports above drywall or plaster ceilings for installation of fixtures weighing more than 40-pounds and secure fixture to structural supports. The use of toggle bolts is prohibited.

D. Recessed Lighting Fixtures - Fire Rated Building Surfaces
   1. Lighting fixtures recessed in ceiling or wall which has a fire resistive rating of 1-hour or more shall be enclosed in a fully enclosed backbox (except over fixture lens/diffuser). The material used to fabricate the "enclosed backbox" shall have a fire rating equal to that of the respective ceiling or wall.
   2. The space from the fixture to the box enclosure shall be a minimum of 3-inches.
   3. The backbox shall be concealed behind the fire rated ceiling and wall finish surface. The light fixture shall be provided with lamp ballast rated for (normal light output) operation in a "high" ambient temperature.

3.02 LAMPS

A. Fluorescent and HID lamps controlled by dimming equipment shall be operated (aged) for 100-continuous hours without interruption, at 100% full lumen output prior to occupancy of the building by the DISTRICT.

B. Lamps shall be the type and manufacturer as recommended by the dimming system manufacturer.

C. Install all lamps in each light fixture.

D. Lamp and light fixture use during construction:
   1. All lamps in lighting fixtures that have been operated (ON) for a total of more than 300-hours prior to final completion of the contract notice of completion, shall be relamped by the CONTRACTOR. Remove the existing lamps with more than 300-hours of illuminated operation and provide new lamps of the type required by the contract documents, install lamps in respective light fixtures, typical for the following lamp types:
      a. Linear fluorescent.
      b. Compact fluorescent (CFL).
      c. H.I.D.
      d. Incandescent.
      e. LED

3.03 LENS AND DIFFUSERS

Lens, diffusers, internal reflectors shall be completely cleaned of all dust, dirt and fingerprints after the installation of the light fixtures and lamps, and after all trades have completed work and prior to occupancy of the facility by the DISTRICT.

3.04 BALLASTS

A. Ballasts remote from the lighting fixture, mounted as shown on the drawings and designed for remote operation. Additional wiring and conduit shall be provided whether shown on the drawing or not, between lighting fixture and remote Ballasts with required quantity of "THHN" wire installed in conduit to operate said fixture(s).

B. Provide proper type and quantity of conductors with conduit system for proper operation of dimming system, whether or not shown on drawings.

C. CONTRACTOR shall tandem wire 1-lamp or 3-lamp fluorescent fixtures when fixture is recessed mounted and within 8-feet of each other or if surface or pendant mounted within 1-foot of each other. To accomplish tandem wiring, a tandem wiring harness shall be installed between inboard master ballast and inboard slave lamp located in adjacent fixture. Night-light or emergency light fixtures shall not apply.

3.05 FLUORESCENT LIGHT FIXTURE TANDEM WIRING CONNECTIONS

A. The contractor shall provide tandem wiring whether or not shown on the drawing for fluorescent lighting fixtures conforming to all of the following criteria:
   1. Light fixture contains fluorescent lamp ballast.
   2. Odd number of lamps in light fixture (i.e., 1-lamp, 3-lamp, 5-lamp, etc.).
   3. Light fixtures are recess mounted within 10-feet of each other; light fixtures are surface mounted or suspended/pendent mounted within 1-foot of each other.
   4. Light fixtures are located in the same room.

B. Provide the tandem wiring connections between respective light fixtures as follows:
   1. The tandem wiring harness shall be the product of the respective lighting fixture manufacturer.
   2. The tandem connection shall provide pre-assembled wiring harness connecting two (2) fluorescent lamps in adjacent lighting fixtures with a master lamp ballast, remote adjacent fixture slave lamp.
   3. The wiring harness shall contain the wiring in flexible steel conduit or enclosed metal raceway/jacket for installation in an air plenum.

C. Delete tandem wiring requirement and provide individual and multi-lamp Ballasts in each respective light fixtures under one or more of the following conditions.
   1. Lighting fixtures are shown as night-light or emergency light type fixtures do not require tandem wiring.
   2. Fluorescent dimming Ballasts do not require tandem wiring.

3.06 COMMISSIONING LIGHTING FIXTURES (ADDITIONAL REQUIREMENTS)

A. General
   1. Verify correct lighting control configurations and operation in each room.
   2. Simulate normal source power failure by "opening" (turn off) building main service disconnect and verify connections and operation of each emergency lighting fixture.
   3. Confirm "EXIT" sign directional arrows are visible in each "EXIT" sign.
   4. Verify light fixture support-hangers, ceiling grid clips and seismic restraints comply with the Contract Documents.
   5. Remove protective shipping/installation shields on fixtures. Verify fixtures and lamps are clean and free of construction debris. Clean light fixtures found to be contaminated or dirty.
   6. Setup, program, and function test lighting control systems to perform each of the indicated control functions, area/room zones and sequences.
   7. Provide “aiming”, directional adjustment of light fixtures, both indoor and outdoor. Aiming shall comply with manufacturer’s aiming diagrams, and as directed by District’s Representative.

B. Sample spot-check in each room the following lighting fixture information:
   1. Lamp type and performance data.
   2. Ballast type and performance data.
   3. Combined lamp/ballast certification of performance and compatibility by respective manufacturer.
   4. Verify instructional signage is placed inside each lighting fixture in compliance with Contract Documents.

END OF SECTION

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
3. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

1.03 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. RCR: Room cavity ratio.

1.04 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast.

4. Energy-efficiency data.
5. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
6. Life, output, and energy-efficiency data for lamps.
7. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
    b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

1. Wiring Diagrams: Power and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.
4. Other items in finished ceiling including the following:

    a. Air outlets and inlets.
    b. Speakers.
    c. Smoke and fire detectors.
    d. Occupancy sensors.
    e. Access panels.

5. Perimeter moldings.

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:

1. Lamps: Specified units installed.
2. Accessories: Cords and plugs.

E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

F. Qualification Data: For agencies providing photometric data for lighting fixtures.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Mockups: Provide interior lighting fixtures for room or module mockups complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.07 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency Fluorescent Ballast Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or

workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Two year(s) from date of Substantial Completion.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 percent of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Battery and Charger Data: One for each emergency lighting unit.
4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified on the Schedule.

2.02 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors,

frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metalized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

K. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."

1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat Removal Units: Air path leads through lamp cavity.
3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.

2.03 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated. All ballasts shall be Sylvania –Osram Xtreme Octron F032 extended performance Super Ecologic lamps and ballast combination System or approved equal by Advance and Phillips lamps as specified on the lighting fixture schedule.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 42 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.71 or higher.
7. Power Factor: 0.98 or higher.
8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

C. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.

D. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

E. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.

a. High-Level Operation: 100 percent of rated lamp lumens.
b. Low-Level Operation: 50 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.04 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.98 or higher.
10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non consumer equipment.
11. Ballast Case Temperature: 75 deg C, maximum.

2.05 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 1 fluorescent lamp continuously at an output of 1100-1400 lumens each. Connect un switched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night-Light Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp continuously. Connect un switched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night-Light Connection: Operate one fluorescent lamp in a remote fixture continuously.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Housing: NEMA 250, Type 1 enclosure.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.06 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 15 percent.

4. Transient Voltage Protection: IEEE C62.41, Category A or better.
5. Lamp Current Crest Factor: 1.5 or less.
6. Power Factor: .90 or higher.
7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
8. Protection: Class P thermal cutout.
9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.
10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.

    a. High-Level Operation: 100 percent of rated lamp lumens.
    b. Low-Level Operation: 50 percent of rated lamp lumens.
    c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.

2.07 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
   2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

   3. Master/Remote Sign Configurations:

      a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
      b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.08 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.09 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 programmed rapid-start low-mercury lamps, rated 32 W maximum, nominal lengths of 48 inches 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K or 4100K as specified, and average rated life 20,000 hours, unless otherwise indicated on the drawings.

C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500or 4100 K, and average rated life of 20,000 hours, unless otherwise indicated on the drawings.

D. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 or 4100 K, average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

2.10 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.12 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

A. See Drawings for Fixture types and specifications:

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.02 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.03 TRAINING

A. Contractor shall train school site staff (as selected) and FASO Technicians on emergency lighting systems operations and maintenance before Beneficial Occupancy, and during the first month of Occupancy. The first training session shall be a two (2) hour session; and the second shall be a one hour session.

END OF SECTION

SECTION 26 52 00
EMERGENCY LIGHTING CENTRAL BATTERY

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.

B. Demonstration and Instruction (ADDITIONAL REQUIREMENTS)
   1. Provide on-site instruction classes and operation manuals to the District's personnel. Two (2) on-site instruction classes shall be conducted by Contractor.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. General
   1. Submit manufacturer product data, dimensional data, ambient environmental data and derating factors, electrical performance data.
   2. Submit performance and technical information on battery calculations and/or factory tests demonstrating capacity capabilities.

1.03 APPLICABLE STANDARDS (ADDITIONAL REQUIREMENTS)

A. General
   1. The equipment shall be listed, labeled and approved for the application show in the contract documents, as a battery stored energy, emergency lighting electrical power inverter, complying with the most recent version of the following Applicable Standards.
   2. The following standards shall become requirements of contract document and are included in the contract documents.

B. Underwriters Laboratory - UL
   1. UL – 924 & 924A Standard for Emergency Lighting and Power Equipment.
   2. UL - 1778 Standard for Uninterruptible Power Supply Equipment.

C. National Fire Protection Agency - NFPA
   1. NFPA - 101 Life Safety Code.
   2. NFPA - 111 Stored Electrical Energy and Standby Power systems.
   3. NFPA – 70 Article 700 Emergency Systems. (NEC) Article 480 Storage Batteries.

D. Federal Communications Commission - FCC
   1. FCC - Class A RFI emission limits.

E. American National Standards Institute – ANSI
   1. ANSI – C62.41 Both Category-A and Category-B and C62.45 Transient Voltage Withstand.

F. Institute of Electrical and Electronic Engineers-IEEE
   1. IEEE – 587 Surge Voltages

G. Seismic Earthquake and wind loading withstand, testing and certification (ADDITIONAL REQUIREMENTS).

1. The complete emergency lighting central battery inverter assembly; including circuit protection devices, meter, housings/enclosures, batteries, accessories, supports/anchors etc., shall be designed, manufactured, and tested.
   a. Wind loading all outdoor equipment locations.

B. Operation
1. During operation under normal mode 60Hz AC power, the supply voltage shall feed both the output load and the battery charger. Upon normal power failure, the output load shall be automatically transferred to internal 60Hz AC emergency mode power operation.
2. When normal power is re-established, the output load shall be automatically transferred back to the normal power AC line and the charger shall commence recharging the batteries to their full capacity.
   b. Earthquake seismic requirements of CBC/IBC Seismic withstand all indoor and all outdoor equipment locations.
2. Shall withstand, survive and maintain continuos non-interrupted energized operation during the seismic event occurrences and wind event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation. Acceptance test seismic qualification of proposed equipment shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
4. Provide three (3) dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading not less than as follows and as required by AHJ:
   a. 100MPH-West coast states USA, California, and Hawaii.
   b. 150MPH-East coast states USA, Gulf coast states USA and Alaska state.
   c. 90MPH-all other USA locations.
5. Seismic test shall be performed by a third party independent test laboratory, shall include batteries. Wind analysis and Seismic Testing and reports shall be certified, signed and “stamped” by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.

H. Short circuit, coordination and ARC-Flash (ADDITIONAL REQUIREMENTS)
1. Perform and submit short circuit fault current, time/current coordination and ARC-Flash fault engineering analysis, for AC and DC circuits.
2. Provide label equipment with warning and instructional signs.

PART 2 - PRODUCTS

2.01 OPERATION

A GENERAL
1. The Emergency Lighting Battery Unit (ELBU) shall be self contained, automatic operation. Unit shall store electrical energy and supply standby back-up electrical energy upon failure of normal (utility source) power and provide operation of lighting and other connected equipment as described in the Contract Documents.
2. ELBU shall consist of an automatic circuit transfer system, input/output circuits, storage batteries, battery charger, voltage inverters, monitoring, test/monitoring equipment and operating program software. Manufactured with all components enclosed in modular cabinetry.
3. ELBU volt-ampere continuous load rating shall be sufficient to provide operation of the full unit rated load. But in no case less, than required to supply all of the connected loads shown on the drawings, plus an additional 20% spare continuous load capacity “Safety·Factor”. All at an 80% (0.80) lagging load power factor.
   a. Normal mode load capacity operation duration shall be continuous.
   b. Emergency mode full 100% rated load capacity operation shall be for the duration time indicated on the drawings, but not less than 90 continuous minutes.
4. Unit shall operate properly in ambient temperatures from 15 to 25 degrees centigrade, sea level to 10,000 feet above sea level, at the specified ratings.
5. Emergency lighting central battery unit shall be as manufactured by Dual-Lite; or Myers Power Products.

B. Operation
1. During operation under normal mode 60Hz AC power, the supply voltage shall feed both the output load and the battery charger. Upon normal power failure, the output load shall be automatically transferred to internal 60Hz AC emergency mode power operation.
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PART 2 - PRODUCTS

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   a. Normal mode load capacity operation duration shall be continuous.
   b. Emergency mode full 100% rated load capacity operation shall be for the duration time indicated on the drawings, but not less than 90 continuous minutes.
4. Unit shall operate properly in ambient temperatures from 15 to 25 degrees centigrade, sea level to 10,000 feet above sea level, at the specified ratings.
5. Emergency lighting central battery unit shall be as manufactured by Dual-Lite; or Myers Power Products.

3. Transfer to emergency mode operation shall occur when normal input voltage drops to less than 60% to 70% of nominal for brownout protection on any input line phase. The transfer to emergency mode shall also occur if there is an open circuit, or shorted circuit on the normal input side. A 15 to 60-second transfer time delay (nominal) back to normal mode operation shall be adjustable to reduce "cycling" operation between normal and emergency operating modes.

2.02 LOAD REQUIREMENTS

A. Load Types
   1. Load output shall be provided for the following types of loads in any loading combination (0 to 100% of load rating), within the rated capacity (0 to 100% of load rating) for 50% (0.5) lag through 50% (1.5) lead load power factors.
   2. Unit shall be suitable for operation and withstand inrush currents associated with the connected loads without damage or changes in its operation including:
      a. Incandescent lamps and ballasts.
      b. Fluorescent lighting fixtures and ballasts.
      c. Electronic equipment including fire alarm equipment.
      d. High Intensity Discharge (H.I.D.) lighting fixtures and ballasts (continuous ARC-sustain operation).
      e. Solid state electronic lighting fixture ballasts and dimmers.
      f. Electromagnetic lighting fixture ballasts and dimmers.
      g. LED (Light Emitting Diode) solid-state lamps and drivers.
      h. Fire door holds open devices.

B. Voltage
   1. Normal power input and output voltage shall be 60Hz, AC single phase or three phase; 120 volt; 208 volt; 240 volt; 277 volt; 120/208 volt 3 wire or 120/240 volt 3 wire. All as indicated on the drawings.
   2. Provide multiple load output voltages, for both normally on and normally off loads, where indicated on the drawings (i.e., 120-volt input - 120 volt and 277-volt load output; 277 volt input-120 volt and 277 volt output; etc.).
   3. The total line input volt-amperes shall not exceed 135% of the unit rated full load output volt amperes and output line voltage, including battery-recharging loads.

C. Circuit Breakers Line and Load
   1. Provide load output circuit breakers, ampacity and quantity as indicated on the drawings, but in no case less than one (1) 20 ampere load output circuit breaker for each 1500 volt ampere (or portion thereof)of unit rated load capacity. Provide the circuit breakers on each normally off and each normally on load out connection and on each load out voltage connection.
   2. Provide a unit main line input circuit breaker in the ELBU. The circuit breaker shall be sized to allow continuous full rated load operation of the ELBU, including battery-recharging loads.
   3. Provide D.C. battery protection internal breakers.
   4. The circuit breakers shall be thermal magnetic molded case type. The Main line input circuit breaker shall be rated a minimum of 42,000-ampere symmetrical short circuit interrupting capacity, but not less than shown on the drawings. Internal and load output circuit breakers shall be “series rated” or “fully rated” to the main input circuit breaker symmetrical short circuit interrupting capacity, at the specified input and output voltage(s).
   5. Monitor and trouble-alarm each circuit breaker for "tripped" or "off" condition.

D. Load Output
   1. Provide output load types as follows (in any combinations up to unit full rated output capacity).
   2. Normally on - Output load is energized in both the normal and emergency modes.

3. Normally off - Output load is energized only when unit is in the emergency mode and de-energized when the unit is in the normal mode.
4. The unit shall function correctly with no load (zero-volt amp) connected to the output terminals. UNITS REQUIRING A MINIMUM CONNECT LOAD FOR CORRECT OPERATION ARE NOT ACCEPTABLE.

E. Load Output Voltage Characteristics
1. During the entire rated operation duration, output voltage shall be sinusoidal wave.
a. Total harmonic distortion shall not exceed 5% under any combination of the specified load conditions.
b. Voltage regulation shall not vary more than plus or minus 5% of rated voltage under all load conditions, no load 0% to 100% of full rated load.
2. Load output voltage frequency regulation shall be within plus or minus 0.5Hz under specified load conditions, when operating on the inverter and batteries.

F. Efficiency When Operating In Any Mode
1. At 100% rated load – greater than 97%.
2. At 50% rated load – greater than 94%.
3. Efficiency shall be measured load output kW divided by the measured line input kW; with a connected load power factor of 0.8 lagging and the batteries fully charged operating on trickle float charge.

G. Internal Bypass Switch
1. Switch shall keep all of the loads circuits energized while the ELBU is shut down (bypass) due to malfunction or maintenance.
2. Three (3) position switch: normal; unit bypass; loads off.

2.03 INVERTERS

A. General
1. Inverters shall be modular and completely solid state. Protected against overloads, in rush loads and short circuits.
2. Inverter shall provide stable regulated output operation from the internal batteries under all specified load conditions.
3. Low battery voltage cutout shall be provided to disconnect the inverter load when the battery output voltage drops below a preset value.
4. Automatic unit restart after initiation and/or restoration of normal input power.

2.04 CONTROL, TESTING AND MONITORING EQUIPMENT

A. Internal control, monitoring and testing with programming software and microprocessor control operation shall be provided to verify proper system operation and trouble conditions. Control, testing, and metering display panel shall be installed in the door of equipment cabinet not more than 6-feet-0-inches above finished floor.

B. System Display/Control Panel
1. The system's display panel shall include an array of visual indicators, multi-line alphanumeric character display, and a keypad to control and monitor the system.
2. The array of visual indicators shall monitor and annunciate the AC utility presence, system ready status, battery charging status, battery emergency operation, and alarm functions.
3. The system shall display alphanumeric meter functions including:
a. Input-voltage and input demand load.
b. Output-voltage, output-frequency, output-demand load and output-power factor.
c. Unit internal component temperatures.
d. Total quantity of power outages and inverter operating time.
4. To ensure only authorized personnel can operate the unit, the system shall be password protected for all control functions, including parametric changes.

C. Alarms
   1. The system shall have audible and alphanumeric visual alarm display, with automatic logging of the twenty (20) most recent alarm events. Each alarm will have a corresponding audible signal associated with it to aid in the troubleshooting of the system.
   2. The system's alarm acknowledge feature shall enable the user to silence only the current audible alarm(s), while not silencing other alarms and not clearing the alarming condition until the fault has been cleared.
   3. Alarms shall monitor low, near low, and high battery voltage; high AC voltage input; high and low AC voltage output; volt-amp output overload; low runtime remaining; high ambient component temperature over limit; check charger, battery, inverter, and memory/logic; emergency power off activated; user test check; and call service.
   4. Alarms on each internal circuit breaker, to indicate when the circuit breaker is in the open/ off/tripped positions.

D. Manual and Programmable Testing
   1. The system shall provide both manual test functions and software programmable automatic test modes. The user shall be able to perform a system test at any time.
   2. The system shall also perform a automatic programmable, weekly, self-diagnostic test and load test of its subsystems to insure the system will operate in an emergency condition. A monthly load test for a user programmable discharge time and an annual test for a complete runtime discharge time and an annual test for a complete runtime discharge.
   3. Automatic recording in memory, of the last twenty (20) inverter events, including all automatic weekly and user programmed tests, shall be logged.

E. Remote Terminal Strip
   1. An auxiliary terminal strip located within the system cabinet shall provide connection points for remote monitoring of inverter status and alarm indication.
   2. Remote monitor/annunciator panel:
      a. Provide a remotely mounted ELBU monitoring/alarm panel, with operating status and alarm conditions visual and audible indicators. Provide an audible alarm silence push-button with automatic resound on subsequent alarms.
      b. The panel shall be enclosed in a Nema 1 for indoor locations, NEMA 3R for outdoor locations. Flush mounted housing, with "see-thru" front cover access door. Tamper resistant construction, suitable for installation in unsupervised public areas.
      c. The remote monitoring and alarm panel shall operate over connecting circuit lengths up to not less than 300-foot distance from the respective ELBU.
      d. Provide remote monitoring and alarm panels adjacent to each fire alarm annunciator panel unless noted otherwise on the drawings.

2.05 BATTERIES

A. General
   1. Batteries shall provide capacity to operate the unit and maintain specified inverter output for indicated years on a pro-rata basis when properly maintained as recommended by the manufacturer.
   2. Flame arresting caps shall be provided on batteries, with catalytic conversion to prevent hydrogen out gassing.
   3. Battery cases shall be translucent to allow visual observation of electrolyte level. Provide earthquake restraint battery mounting straps.

B. Battery Seismic Restraint
   1. Batteries shall be installed in the unit with seismic restraint anchors and straps.

C. Battery Type
   1. Batteries shall be nickel cadmium low maintenance type to reduce the need to replenish battery fluids. Batteries shall be 25-year design life expectancy at 77-degrees Fahrenheit ambient, pocket plate construction. Maximum battery discharge shall be automatically

limited to the value recommended by battery manufacturer of nominal battery voltage, with full rated unit output during discharge.

2.06 BATTERY CHARGER

A. General
1. Battery charger shall be solid state specifically designed for the type of batteries used in the system.
2. Battery charger shall have automatic protection against short circuits, low battery condition, DC-over voltage protection and protected against thermal runaway.
3. Charger shall automatically maintain correct battery charge conditions, with float charging and periodic equalize battery charges, within plus or minus 0.05 volts of battery manufacturer's recommendations.
4. The charger shall completely restore fully discharged batteries from the input line source, to full battery charge condition in less than 24 hours.

2.07 CABINET

A. General
1. The cabinetry shall contain all components, inverter, transformers, power supplies, battery charger, including the batteries, free standing with hinged locking door. All components shall be accessible from the front for maintenance and removal.
2. Units requiring side access for cooling air or maintenance shall not be acceptable unless the drawings specifically show the permitted side access space provisions.
3. Provide water shields on cabinets, to protect the ELBU from fire sprinkler discharge water damage.

B. Cabinet Construction
1. The cabinets shall be metal, NEMA 1 enclosure, equipped with a key-operated access lock.
2. Manufacturer's standard finish color with rust inhibitor "primer" and acid-resistant finish paint.
3. Battery shelves shall permit the batteries to be tested or have battery fluids added without having to remove the batteries.
4. The doors shall open full without affecting the operation of the unit. Conduit knockouts shall be provided on both sides, bottom and top of the cabinet for connection of line and load circuits. Provide dead front or insulated covers over exposed energized parts to prevent accidental contact, when doors are open.

C. Electrical Connections
1. Provide line and load terminal lugs and identification tags on all circuits.

D. Size
1. Maximum cabinet size including batteries shall not exceed those shown on drawing, but in no case larger than as follows:
a. Up to 4600VA at 80% power factor rated load output: 43-inches wide by 84-inches high by 21-inches deep.
b. 4601VA to 11000VA at 80% power factor rated load output: 85-inches wide, by 84-inches high by 24-inches deep.
c. 11001VA to 17,500VA at 80% power factor rated load output: 128-inches wide by 84-inches high by 26-inches deep.

2.08 COMMUNICATION PORTS

A. General
1. The ELBU shall provide a standard RS-232 bi-directional serial communications port, for communicating with portable computers. Provide software with the ELBU for control, monitoring and diagnostic/maintenance operations of the ELBU. The software shall

operate on Microsoft-Windows based, PC style computers, using 3.5-inches “floppy-disk” magnetic storage media, or 5.25-inch “CD/DVD” ROM.
2. The PC computer is not included in the contract scope of work.

B. Remote Monitoring and Control
1. Facsimile/Modem Communications Panel: Shall automatically transmit system’s operating status reports over a dedicated “dial-up” telephone line to remote locations. Provide 1-inch conduit with (ANSI/EIA/TIA-568B) two (2) Category-6, 4-pair, UTP cables and homerun to IDF/MDF telephone terminal.
2. Each designated location shall automatically receive a unit status reports transmission following all monthly and annual test cycles or when an alarm conditions is detected by the system’s self-diagnostic electronics.
3. Status reports shall be software programmable and include readings on key operating parameters as well as complete alarm and inverter log printouts.
4. The ELBU Manufacturer shall provide 364 calendar days duration, remote monitoring and supervision of each ELBU. The start date shall begin from the Construction Contract substantial completion date, notice of completion. Provide not less than two (2) written status reports, to the District’s Representative, at 180 calendar days and 330 calendar day milestones.
5. The District and Manufacturer shall have the option to renew the manufacturer’s monitoring control contract at a negotiated fair market price and terms, at the end of the initial 364 calendar day periods.

C. Monitoring and Communications Circuits
1. Provide monitoring and communication circuits as follows:
   a. One (1) 0.75-inch conduit, homerun from each ELBU to nearest telephone/data terminal backboard, with two (2) EIA/TIA-568C Category-6A 4-pair UTP communication cables in conduit.
   b. One (1) 0.75-inch conduit, homerun from each ELBU to Building Automation System (BAS) communications transponder, with two (2) EIA/TIA-568C Category-6A, 4-pair UTP communications cables in conduit.

PART 3 - EXECUTION

3.01 TESTING

A. General
1. All units and batteries shall be inspected for damage as soon as they are received. Specifically check to see if wet cell batteries have been turned over in shipment and whether the equipment cabinets have received any severe dents which might cause internal damage. Remove and replace all damaged equipment with new undamaged equipment.
2. Use only the factory provided knock-out areas and conduit entry provisions on the equipment for wiring. Care shall be taken not to let metal slugs or chips get into the equipment cabinet.
3. Prior to energizing equipment, perform measurements on the incoming and load output AC lines to the equipment to insure that the proper voltage level is available and that there are no ground faults or high potentials between conductors or between phase conductor to neutral/ground.
4. Prior to installing the fuses, or closing the circuit breaker in the battery circuit, verify correct battery voltage, polarity markings, battery electrolyte level and all electrical connections are secure.
5. Prior to turning the system on for any tests, the unit shall be bypassed with the mains connected to feed the load directly and the currents in each conductor measured and balanced. Follow Manufacturers instructions for installation, connection and energizing equipment.

6. Batteries which are shipped with the electrolyte in the battery cells shall be maintained on a float charger when not installed and energized, operating the emergency power unit. Batteries shipped without electrolyte installed in the battery cells shall not have electrolyte added until equipment is installed and ready to be energized. Batteries which are not handled with this procedure will be rejected, shall not be used and shall be replaced with new batteries at the CONTRACTORS expense.
7. Provide factory authorized field service technician factory start-up to inspect, energize, test and certify the correct system installation, connections and operation. Provide written acceptance field service report, six (6) copies, to District's Representative.

B. Commissioning (ADDITIONAL REQUIREMENTS)
1. Setup, testing, startup, and commissioning shall be performed by factory technician(s) trained, certified and authorized by the equipment manufacturer. Final commissioning shall be performed after installation and connections are complete.
2. Provide system programming and setup of all control sequences for the emergency/exit lighting control system.
3. Simulate normal source power failure by opening (turn-off) building main service disconnect and verify connections and operation of each electrical system device connected to the system on both normal power source and emergency power sources. Simulated test time for operating duration connected on the emergency systems shall be not less than 90 continuous minutes without failure or anomalies in the system.
4. Record and document electrical demand load and sequence of operations on the ELBU system with all connected loads operating, including but not limited to:
   a. Fire alarms
   b. Egress/exit lighting
   c. Doors
   d. auto-loading and overload shedding controls
5. Test all control system functions after the installation and connections are complete and the system has been energized. Verify each control sequence of operation and each device to be controlled are each operating correctly.
6. Record and document each device setup and program setting.
7. Submit written report (6 copies) to District's Representative certifying commissioning has been preformed; all respective systems are operating correctly and document all software setup and each device setting.

3.02 SEISMIC EARTHQUAKE

A. General
1. The entire unit shall be installed and anchored to building structure to comply with Seismic earthquake requirements.
2. Install seismic restraints on all batteries.

3.03 FACTORY SERVICE AGREEMENT (FIRST YEAR OPERATION)

A. General
1. Provide site visits and written reports for each ELUB at unit start-up, commissioning, and again approximately 12 months after completion of testing and commissioning. Shall be included as part of the base contract scope.
2. Factory authorized technician shall test all ELUB options, accessories and functions, physical, electrical and mechanical inspection. Simulate normal source power outage and recharge functions.
3. ELUB factory remote monitoring and reporting of each ELUB status, using telephone communications line provided by the DISTRICT.
4. The base contract initial first year operation service scope shall be renewable, if mutual agreement between the ELUB manufacturer and the District is accomplished for service cost, scope and renew.

5. Provide one training and instruction class to FASO technicians, and any necessary site staff before beneficial occupancy; and one class conducted with FASO technicians during first three months of Occupancy.

6. Provide three (3) copies of factory service proposal renew agreement to the District's Representative.

END OF SECTION

SECTION 26 56 00 - EXTERIOR LIGHTING

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:

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.

B. Related Sections:

1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photoelectric relays.
6. Ballasts, including energy-efficiency data.
7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

E. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.

C. 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.

D. Comply with IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.

D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

Color: As selected from manufacturer's standard catalog of colors. Color: Match Architect's sample of manufacturer's standard color

.

Color: As selected by Architect from manufacturer's full range.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

Color: Light bronze.

O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:
"USES ONLY" and include specific lamp type.
Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires. ANSI ballast type (M98, M57, etc.) for HID luminaires. CCT and CRI for all luminaires.

2.3 FLUORESCENT BALLASTS AND LAMPS

A. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F (minus 18 deg C) and higher.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
Lamp end-of-life detection and shutdown circuit.
Automatic lamp starting after lamp replacement.

Sound Rating: Class A.
Total Harmonic Distortion Rating: Less than 20 percent.
Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
Operating Frequency: 20 kHz or higher.
Lamp Current Crest Factor: 1.7 or less.
BF: 0.95 or higher unless otherwise indicated.

2.5 BALLASTS FOR HID LAMPS

1. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:
   Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
   Normal Ambient Operating Temperature: 104 deg F (40 deg C).
   a. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

3. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
   a. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
   b. Restrike Range: 105- to 130-V ac.
   c. Maximum Voltage: 250-V peak or 150-V ac rms.
   d. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

2.6 HID LAMPS

1. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), CCT color temperature 1900 K, and average rated life of 24,000 hours, minimum.
   a. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.

2. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature 4000K.

c. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
Install grounding electrode for each pole unless otherwise indicated.
Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
Install grounding electrode for each pole.
Install grounding conductor and conductor protector.
Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
2. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
3. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
4. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
5. IESNA LM-64, "Photometric Measurements of Parking Areas."
6. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 26 05 48
SOUND CONTROL

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 (ADDITIONAL REQUIREMENTS)

A. Comply with pertinent provisions of Division 26.

B. Submit product data sheets for vibration isolation devices.

C. Submit detailed shop drawings including dimensioned plans, showing equipment vibration isolation anchoring.

PART 2 - PRODUCTS AND EXECUTION

2.01 QUIETNESS OF OPERATION

Before the work will be accepted as complete, quietness of operation, to a degrees satisfactory to the ARCHITECT, shall be attained for apparatus, equipment, fixtures, etc., included under the electrical work. Provide isolation and vibration protection required.

2.02 VIBRATION ISOLATION FOR ELECTRICAL EQUIPMENT

A. Objective: It is the objective of this specification to provide the necessary design for the avoidance of excessive noise or vibration in the building due to the operation of machinery or transformers, and/or due to interconnected conduit.

B. CONTRACTOR Responsibility
   1. Provide a submittal to the ARCHITECT for review prior to any installation of his equipment, containing the following information:
      a. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specification.
      b. An itemized list showing the items of equipment to be isolated, the isolator loading and deflection and isolator placement.
      c. Drawings showing methods for attachment of conduit to motors.
   2. Furnish and install the vibration isolation devices as specified herein.
   3. Do not install any equipment or conduit as specified in the schedule, which makes rigid contact with the “building” unless it is approved in this specification, or by the ARCHITECT. "Building" includes slabs, beams, studs, walls, lath, etc.
   4. Coordinate work with other trades to avoid rigid contact between equipment or conduit as specified in the schedule and the building. Inform other trades following his work, such as plastering, to avoid any contact that would reduce the vibration isolation.
   5. Bring to the ARCHITECT'S attention, prior to installation, any conflicts with other trades which will result in unavoidable contact to the equipment or conduit as specified in the schedule, described herein due to adequate space, etc. Corrective work necessitated by conflicts after installation shall be at the responsible CONTRACTOR'S expense.
   6. Bring to the ARCHITECT'S attention any discrepancies between the specifications and field conditions, changes required due to installation. Corrective work necessitated by discrepancies after installation shall be at the CONTRACTOR'S expense.

7. Obtain approval from the ARCHITECT of any installation to be covered on enclosed, prior to such closure.
8. Obtain written and/or oral instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices.
9. Notify the ARCHITECT, prior to the general installation of vibration isolation devices, so that the ARCHITECT can instruct and demonstrate the technique of proper installation with the CONTRACTOR'S foreman.
10. Correct, at no additional cost, all installations, which are deemed to be defective workmanship or materials by the ARCHITECT.

2.03 VIBRATION ISOLATION TYPES

A. Isolator Description
1. Isolate all transformers with Type MN molded neoprene units equipped with leveling bolts and design status deflection under load of 0.3-inch.
2. Isolate all switchgear connected directly to transformer with Type PN isolators. Limit loading to a static deflection of 0.06 inch. Choose the area of pad to match the load with the manufacturer's recommended unit loading. An auxiliary steel plate may be required to distribute the load uniformly over the pad area.

B. Equivalent Vibration Isolators

1. Type Description	A	B	C	D	E	F	G
Neoprene Mount							
a) 0.2-inch max. deflection	N	FD	R	RV	CS	F	T-44
b) 0.4-inch max. deflection	ND	FDD	RD	RFD	FU	RD	T-44
PN Neoprene Pad	W	(1)	(2)	NR	R	(3)	100W

2. Notes
(1) Elastrogrip
(2) Shearflex
(3) Kinetic

Manufacturer's Code
A. Mason Industries
B. Korfund
C. Vibration Mounting
D. Amber/Booth
E. Sausse
F. Consolidated Kinetics
G. Vibration Eliminator

2.04 CONDUIT INSTALLATION

A. Provide flexible conduit or an approved vibration isolation device between any transformer and the building structure.

B. Secure all electrical panels connected to transformers by flexible conduit to the floor. Do not contact stud or masonry partitions. Isolated panels from the floor as specified herein.

C. Provide flexible conduit connections to all connections to air conditioning, plumbing, etc., or any rotating or oscillating equipment requiring electrical motors. Base the length of flexible conduit required for each motor upon the requirements for a 360 degrees loop in the conduit between the electrical motor and electrical box.

D. As an alternative to the 360 degrees loop, a Neoprene or rubber bushing between the conduit and the electric motor to break the metal-to-metal contact may be used. Provide a flexible ground strap to complete the electrical ground.

2.05 DEVICE OUTLET BOXES (INSTALLED IN COMMON PARTY SEPARATION WALLS, IN CORRIDOR WALLS AND SERVICE WALLS).

Device outlet boxes installed in walls shall be sealed on the exterior back and sides of the boxes, including wall openings around the box, with a 1/8-inch minimum thickness resilient sound absorbing, sealant. The sealant shall be free of asbestos, temperature rated from -30 F to 200 F,

self adhesive to metal and plastics, as manufactured by Lowry and Associates Inc. Sun Valley, CA. or equal.

END OF SECTION

SECTION 09 51 00

ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

C. Supplementary acoustical insulation above ceiling.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Do not install acoustical units until after interior wet work is dry.

1.03 SUBMITTALS

A. See Section 01 33 13 - Submittal Procedures.

B. Shop Drawings: Indicate grid layout and related dimensioning.

C. Product Data: Provide data on suspension system components.

D. Samples: Submit two full size samples illustrating material and finish of acoustical units.

E. Samples: Submit two samples each, 12 inches long, of suspension system main runner.

F. Manufacturer's Installation Instructions: Indicate special procedures.

G. Maintenance Materials: Furnish the following for Glendale Unified School District's use in maintenance of project.

1. See Section 01 60 OO- Product Requirements, for additional provisions.

2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.04 QUALITY ASSURANCE

A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Comply with Specifications of the California Department of Public Health (CDPH) Standard Practice.

1.05 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after-acoustical unit installation.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

A. Acoustical Units- General: ASTM E1264, Class A.

B. Acoustical Panels Type AC-1: Painted mineral fiber, ASTM E 1264 Type Ill, Form 2, Pattern C E with the following characteristics:

1. VOC Content: As specified in Section 01 6116.
2. Size: 24 x 48 inches.
3. Thickness: 3/4 inches.
4. Composition: Wet felted.
5. Light Reflectance: 0.90 percent, determined as specified in ASTM E 1264.
6. NRC Rating: 0.70, determined as specified in ASTM E 1264.
7. Ceiling Attenuation Class (CAC): 35-39, determined as specified in ASTM E 1264.
8. Edge: square.
9. Surface Color: White.
10. Surface Pattern: medium textured.
11. Product: Ultima, Item 12913HRC, by Armstrong World Industries, www.armstrong.com.
12. Suspension System: Exposed grid Type 1.

2.02 SUSPENSION SYSTEM(S)

A. Manufacturers:

1. Same as for acoustical units.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. System Description:

1. Seismic Loads: Design and size components to withstand seismic loads in accordance with ASCE 7-05, Chapter 13 as specified by the International Building Code, Chapter 16. Specific seismic requirements for suspended ceiling are located in ASCE section 13.5.6
2. Comply with ASTM C635; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.

C. Exposed Steel Suspension System Type 1: Formed steel, commercial quality cold rolled; heavy-duty.

1. Profile: Tee; 15/16 inch wide face.
2. Construction: Double web.
3. Finish: White.
4. Product: Prelude XL HRC by Armstrong World Industries, Inc., www.armstrong.com.

2.03 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Attachment Devices: In accordance with the ASCE 7-05, Chapter 13 as specified by the International Building Code, Chapter 16. Specific seismic requirements for suspended ceiling are located in ASCE section 13.5.6, for Category D, E, and F.

C. Wire for Hangers and Ties: In accordance with the ASCE 7-05, Chapter 13 as specified by the International Building Code, Chapter 16. Specific seismic requirements for suspended ceiling are located in ASCE section 13.5.6.

D. Perimeter Moldings at walls: Same material and finish as grid.

1. At Exposed Grid: Nominal 15/16 inch x 15/16 inch hemmed, pre-finished angle molding (7809).

E. Ceiling Trim at exposed edges: 150 mm high Axiom Classic Ceiling Trim by Armstrong World Industries or approved equal.

1. Color: Match adjacent ceiling tile.

F. Provide BERC2- 2 inch Beam End Retaining Clip, 0.034 inch thick, hot-dipped galvanized cold-rolled steel per ASTM A568 - used to join main beam or cross tee to wall molding.

G. Provide SJCG- Seismic Joint Clip, 5 inches x 1-1/2 inch, hot-dipped galvanized cold-rolled steel per ASTM A568. The two piece unit is designed to accommodate a seismic separation joint. The clip is compatible with 15/16 inch and 9/16 inch grid systems including Prelude, Suprafine, and Silhouette The SJCG is not suitable for use with Vector panel installations.

H. Provide SJMR15- Seismic Joint Clip- Main Beam, 1 inch x 4 inches, commercial quality cold rolled hot dipped galvanized steel per ASM A568, chemical cleansed.

I. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

C. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

A. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.

1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.03 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system and panels in accordance with the ASCE 7-05, Chapter 13 as specified by the International Building Code, Chapter 16. Specific seismic requirements for suspended ceiling are located in ASCE section 13.5.6., except as noted in Section 4.4.3.1 of ESR-1308, and with the authorities having jurisdiction.

B. ESR-1308, Section 4.4.3.1, Alternate Seismic Design Category D,E and F Installation:

1. Under this installation, the runners must be rated heavy-duty and have a minimum simple span uniform load of 16.35 pounds per lineal foot (238 N/m); maximum ceiling weight permitted is 4.0 pounds per square foot (19.5 kg/m2).

2. The BERC-2 clip is used to secure the main runners and cross runners on two adjacent

walls to the structure and the two opposite walls to the perimeter trim, as detailed below. A nominal 7/8-inch (22 mm) wall molding is used in lieu of the 2- inch (51 mm) perimeter supporting closure angle required by Section 9.6.2.6.2.2 (b) of ASCE-7 for Seismic Design Categories D, E and F. Except for the use of the BERC-2 clip and the 7/8-inch (22 mm) wall molding and elimination of spreader bars, installation of the ceiling system must be as prescribed by the applicable code.

3. The BERC-2 clip is attached to the wall molding by sliding the locking lances over the hem of the vertical leg of the wall molding. Clips installed on the walls where the runners are fixed are attached to the runner by a sheet metal screw through the horizontal slot in the clip into the web of the runner.

   a. Alternate #2: If acceptable to architect, fixed attachment may be accomplished by pop-riveting the runner to the wall molding.

4. Clips installed on the walls where the runners are not fixed to the runner allow the terminal runner end to move 3/4 inch (19.1 mm) in both directions. BERC-2 clips installed in this manner are an acceptable means of preventing runners from spreading in lieu of spacer bars required in CISCA 3-4, which is referenced in ASCE 7, Section 9.6.2.6.2.2, which is referenced in ASCE 7-05, Chapter 13 as specified by the International Building Code; Chapter 16. Specific seismic requirements for suspended ceiling are located in ASCE section 13.5.6.

C. The SJCG Seismic Separation Joint Clip is to be installed per the manufacturer's instructions, CS-3815.

D. The SJMR15 Seismic Joint Clip Main Beam is to be installed per the manufacturer's instructions, CS-3955.

E. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

F. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

I. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

J. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION- ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install units after above-ceiling work is complete.

E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

F. Cutting Acoustical Units:

1. Cut to fit irregular grid and perimeter edge trim.
2. Make field cut edges of same profile as factory edges.
3. Double cut and field paint exposed reveal edges.

G. Where round obstructions occur, provide preformed closures to match perimeter molding.

3.05 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

EXECUTION

4.01 USE OF PREMISES

A. CONTRACTOR shall coordinate Work of all trades, Subcontractors, utility service providers, with OWNER and/or Separate Work Contract. CONTRACTOR shall sequence, coordinate, and perform the Work to impose minimum hardship on the operation and use of the existing facilities and/or Project site. CONTRACTOR shall install all necessary protection for existing improvements, Project site, property, and new Work against dust, dirt, weather, damage, vandalism, and maintain and relocate all protection to accommodate progression of the Work.

B. CONTRACTOR shall confine entrance and exiting to the Project site and/or facilities to routes designated by the DISTRICT

C. Within existing facilities, OWNER will remove portable equipment, furniture, and supplies from Work areas prior to the start of Work. CONTRACTOR shall cover and protect remaining items in areas of the Work

D. CONTRACTOR is advised school may be in session during performance of the Work. CONTRACTOR shall utilize all available means to prevent generation of unnecessary noise and maintain noise levels to a minimum. When required by the DISTRICT, CONTRACTOR shall immediately discontinue noise-generating activities and/or provide alternative methods to minimize noise generation. CONTRACTOR shall install and maintain air compressors, tractors, cranes, hoists, vehicles, and other internal combustion engine equipment with mufflers, including unloading cycle of compressors. CONTRACTOR shall discontinue operation of equipment producing objectionable noise as required by the DISTRICT.

E. CONTRACTOR shall furnish, install, and maintain adequate supports, shoring, and bracing to preserve structural integrity and prevent collapse of existing improvements and/or Work modified and/or altered as part of the Work.

F. CONTRACTOR shall secure building entrances, exits, and Work areas with locking devices as required by the DISTRICT.

G. CONTRACTOR assumes custody and control of OWNER property, both fixed and portable, remaining in existing facilities vacated during the Work.

H CONTRACTOR shall cover and protect surfaces of rooms and spaces in existing facilities turned over for the Work, including OWNER property remaining within as required to prevent soiling or damage from dust, dirt, water, and/or fumes. CONTRACTOR shall protect areas adjacent to the Work in a similar manner. Prior to OWNER occupancy, CONTRACTOR shall clean all surfaces including OWNER property.

I. CONTRACTOR shall not use or allow anyone other than OWNER employees to use facility telephones and/or other equipment, except in an emergency. CONTRACTOR shall reimburse OWNER for telephone toll charges originating from the facility except those arising from emergencies or use by OWNER employees.

J. CONTRACTOR shall protect all surfaces, coverings, materials, and finished Work from damage. Mobile equipment shall be provided with pneumatic tires.

K. CONTRACTOR is advised OWNER will award Separate Work Contracts at this Project site.

L. CONTRACTOR shall not permit the use of portable and/or fixed radio's or other types of sound producing devices including walk mans and similar devices.

4.02 PROPERTY INVENTORY

A. Property, OWNER intends to remove; will be removed by OWNER before a room or space is vacated for the Work. Before performing Work in each room or space, DISTRICT and CONTRACTOR shall prepare a detailed initial written inventory of OWNER property remaining within, including equipment and telephone instruments and the condition thereof. DISTRICT and CONTRACTOR shall retain a signed copy of the inventory dated and signed by both parties. Prior to subsequent OWNER occupancy of each such room or space, DISTRICT and CONTRACTOR shall perform a final inventory of OWNER property and all discrepancies between the initial inventory and final inventory shall be the responsibility of CONTRACTOR.

4.03 FURNITURE, FIXTURES AND EQUIPMENT (MATERIALS) OWNER FURNISHED CONTRACTOR INSTALLED (OFCI)

A. Certain materials identified in the Contract Documents as OWNER Furnished CONTRACTOR Installed, OFCI, will be delivered to the Project site by the OWNER.

B. If designated in the Contract Documents to be OWNER furnished CONTRACTOR installed, (OFCI), and **CONTRACTOR** shall unload, store, uncrate, assemble, install, and connect OWNER supplied materials.

C. Forty Eight (48) hours before the date the CONTRACTOR needs to have the OFCI materials on site, CONTRACTOR shall notify OWNER of the scheduled date for needed OFCI materials. Upon delivery to Project site, CONTRACTOR shall store OFCI materials inside rooms and/or protected spaces and will be responsible for security of OFCI materials until Substantial Completion. DISTRICT will sign receipt or bill of lading as applicable.

D. CONTRACTOR shall, within one (1) day after delivery, uncrate and/or unpack OFCI materials in presence of OWNER who shall inspect delivered items. OWNER shall prepare an inspection report listing damaged or missing parts and accessories. OWNER shall transmit one (1) copy of the report to CONTRACTOR. OWNER will procure and/or replace missing and or damaged OFCI materials, as indicated in inspection report.

E. CONTRACTOR shall install OFCI materials in the locations and orientation as indicated in the Contract Documents. CONTRACTOR shall verify exact locations with DISTRICT before final installation of OFCI materials.

F. If required, DISTRICT will furnish setting and or placement drawings for OFCI materials.

G. CONTRACTOR shall install OFCI materials by proper means and methods to ensure an installation as recommended by the manufacturer. CONTRACTOR shall furnish and install all necessary fasteners and required blocking to properly install OFCI materials.

H. CONTRACTOR shall install OFCI materials with manufacturer recommended fasteners for the type of construction to which the OFCI materials are being fastened and/or anchored.

I. CONTRACTOR shall provide final connections of any electrical, signal, gas, water, waste, venting and/or similar items to OFCI materials. CONTRACTOR shall, prior to final connection, verify the operating characteristics of OFCI materials are consistent with the designated supply.

J. . General: All such work indicated in Contract Documents and/or specified herein.

k. Coordination:

1. Contractor shall schedule and coordinate Owner work with his work; give 5 days min. advance notice of all dates; verify that Owner work has been accomplished prior to beginning his work

L. Owner Furnished Items or Products (IF ANY):

1. Owner Responsibilities:

a. Delivery of items or products to site.

b. Schedule delivery date with supplier in accord with Contractor's schedule.

c. Obtain installation drawings and instructions.

d. Submit claims for transportation damages.

e. Arrange guarantees, warranties.

2. Contractor's Responsibilities:

a. Schedule required delivery date for each product, and inform Owner.

b. Promptly inspect delivered products, report damaged or defective items.

c. Unload; handle at site, including uncrating and storage.

d. Protect from exposure to elements, from damage.

e. Repair or replace items damaged as result of Contractor's operations.

f. Install, connect, finish products.

B. The Contractor shall provide adequate storage within his fenced staging area, to store the equipment. The Contractor is solely responsible for the storage of this equipment within his staging area and all subsequent movement of this equipment. The Contractor shall be solely responsible for the maintenance and protection of all material.

C. Bidders submitting under this Contract shall include the price for all necessary coordination with the District and the equipment manufacturer, as required for proper and complete coordination between all trades and all Contractors, within their bid.

4.04 WORK BY OTHERS

A. The District reserves the right to do other work in connection with the project or adjacent thereto by contract or otherwise, and Contractor shall at all times conduct the work so as to impose no hardship on District or others engaged in District's work nor to cause any unreasonably delay or hindrance thereto.

B. Where two or more Contractors are employed on related or adjacent work, each shall conduct their operation in such a manner as not to cause delay or additional expense to the other.

C. Contractor shall be responsible to others engaged in the related or adjacent work for all damage to work, to persons, or for loss by failure to finish the work within the specified time for completion. Contractor shall coordinate his work with the work of others so that no discrepancies shall result in the project.

PART 9 – GENERAL NOTES

5.01 GENERAL NOTES

A. Work areas and detailed scope of work are shown under PART 2.01.

B. It is the responsibility of the contractor to examine the site of the work and after investigation to decide for himself the character of materials, equipment and utilities to be encountered and all other conditions affecting the work. It is also his responsibility to provide sufficient costs to cover the provisions of all items of work under the existing conditions referred to herein.

C. CONTRACTOR is responsible to review the AHERA – Inspection reports for any presence of asbestos containing materials (ACM). CONTRACTOR shall immediately notify OWNER of the presence or suspected presence of any ACM found during the course of the work, prior to the disturbance of the subject materials. At the sole direction of the OWNER, contractor may be required to stop all work on all or any portion of the project until ACM materials are properly abated by OWNER.

C. All work areas have available access. The Contractor will be issued keys for the sites through the District Facilities and Support Operations Department to allow access at the sites. Contractor will ensure they secure all areas that are accessed by their personnel to ensure the security of the site.

D. Contractor shall provide trash bins and storage facilities for use at the site. The contractor shall not use school facilities for these purposes. It will be the contractor's responsibility to maintain and keep those facilities neat and clean at all times.

E. There may be other contractors or District workers working at the job site. Contractor will be responsible to coordinate his work with their schedules.

F. The Representative will have the right to stop the work immediately in case he sees a discrepancy or work not following the specifications. The contractor will not be let to continue to work until corrections are made and approval and permission given by the District Representative.

5.02 RESTRICTIONS

A. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the work areas in which the work is indicated. Allow for Owner occupancy and use by the public.

B. Use of the Existing Buildings: Repair damages caused by construction operations. Take all precautions necessary to protect the existing buildings and their occupants during the construction period.

C. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, other contractors working, and emergency vehicles at all times.

D. Full Owner Occupancy: The Owner may occupy the site and existing buildings during the entire construction period. Cooperate with the owner during construction operations to minimize conflicts and facilitate owner usage. Perform the work so as not to interfere with the Owner's operations.

5.03 PERMISSIBLE WORKING DAYS AND HOURS

A. Work may be conducted as follows:

B. This school is on a traditional school year calendar, August through June. During the period of this contract, school events and educational requirements will limit or prevent access, and will affect Contractor work hours for a portion or all of the school building (s) pertinent to the contract. Contractor shall maintain schedule with full knowledge of these times and dates to be determined. A site-specific calendar will include currently known dates of limited access, or times of the school day that noise will have to be limited, or ceased. These shall include during the time of the project, but not be limited to:

1. No work after 6:00 p.m. on six (6) weekday evenings for back-to-school, open house, and other events per school year at each school site.

2. No work between 8:00 a.m. and 10:00 a.m. on five (5) student attendance weekdays for assembly events per school year.

3. NO NOISE/WORK will be allowed on an Elementary school site between 8:00 a.m. and 12:30 p.m. on twelve (12) student attendance weekdays for testing (four (4) consecutive weekdays, three times) per school year. Second shift work may be accommodated with the request pre-approved by the District Project Manager.

4. NO NOISE/WORK will be allowed on a Middle School or High School site between 8:00 a.m. and 1:30 p.m. on twenty (20) student attendance weekdays for testing (four (4) consecutive weekdays during the first semester; sixteen (16) consecutive weekdays during the second semester) per school year. Second shift work may be accommodated with the request pre-approved by the District Project Manager.

C. It shall be noted that there are students in the Early and Extended Education Learning Program in attendance on the Elementary school sites from 6:00 a.m. through 6:00 p.m. on a daily basis throughout the school year, and on each day that Classified Staff are assigned working hours (see specific EEELP calendar for each site, per each school year).

D. Work hours for the Project shall be from 7:00 a.m. until 10:00 p.m. Monday through Saturday, unless advance permission to deviate from these hours is obtained from the City of Glendale per Glendale Municipal Code, Title 8, Chapter 36, and this request is also approved in writing five working days beforehand by the District Project Manager.

E. Subject to local ordinances, CONTRACTOR may work any hours on Saturdays, Sundays, and any non-school session days, when written notification to the District has been submitted and the anticipated schedule of work has been approved.

SECTION 01 74 10

CLEANING

PART 10 - GENERAL

10.01 SECTION INCLUDES:

A. Maintain premises and adjacent public and private properties free from accumulations of waste, debris, and rubbish, caused by operations during the project.

B. At completion of Work, remove waste materials rubbish, tools, equipment, machinery and surplus materials, and clean all exposed surfaces; leave project clean and ready for occupancy.

PART 10.2 - PRODUCTS

10.2.01 MATERIALS:

A. Use only cleaning materials recommended by the manufacturer of surface to be cleaned.

B. Use cleaning materials only on proper surfaces recommended by the manufacturer.

PART 10.3 - EXECUTION

10.3.01 DURING CONSTRUCTION:

A. Execute daily cleaning plans from each trade to ensure that buildings, grounds, and public and private properties are maintained free from accumulations of waste materials, rubbish and trash on a daily basis.

B. Wet down dry materials and rubbish to prevent blowing dust and debris on and from the construction work.

C. Daily, during progress of work, clean construction site and utilized public properties, and dispose of waste materials, debris and rubbish.

D. Provide on-site steel dump containers and appropriately sized trash containers for collection of waste materials, debris and rubbish. DO NOT USE SITE CONTAINERS.

E. Remove waste materials, debris and rubbish from site and legally dispose of at public or private dumping areas off the District's property.

F. Vacuum clean and wet wipe interior building walls, floors, doors, windows, and hardware in preparation for and when ready to receive finish preparation and painting. Continue vacuum cleaning on an as-needed basis until building is ready final inspection by the Architect, Inspector, and Project Manager and determined to be ready for substantial completion and occupancy.

G. Handle materials in a controlled manner to minimize any unnecessary waste or debris emanating from the construction areas. Do not drop or throw materials from heights: rather, a closed chute shall be used, to minimize unnecessary dust, waste or debris from the construction area.

A. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not migrate into new equipment or furniture, or onto wet, newly painted, or finished surfaces.

10.3.02 FINAL CLEANING:

A. Employ experienced workmen, or professional cleaners, for final cleaning.

B. Exterior: Clean surfaces of the construction and site including, but not limited to, fixtures, walls, soffits, floors, hardware, roofs, window and opening ledges and sills, horizontal projections, steps and platforms, walkways, rails and all like surfaces, and adjoining private and public property to the extent soiled by the Contractor's operations.

C. Interior: Leave all horizontal and vertical surfaces in vacuum cleaned, wet-wiped condition with all dust, dirt, stains, hand marks, paint spots, droppings, and other blemishes and defects completely removed, and conform to the following requirements:

1. Hard Floors: Freshly administer specified product sealants, and Wet mop/wash and dry, concrete, Portland cement flooring, tile, elastomeric, epoxy, refinished and colored concrete, and similar hard floor surfaces free of dust, streaks or stains.

2. Resilient Flooring: Freshly wax and buff as specified in Section 09 65 00.

3. Wood Flooring: Remove defects and blemishes by sanding surface and painting according to Section 09 90 00.

4. Resilient Bases: Clean off adhesive smears and wipe clean with wet-wipe methods.

5. Unpainted and Painted Surfaces: Clean of dust, lint, streaks or stains, utilizing wet-wipe methods as necessary.

6. Tile Walls: Clean and polish per manufacturer's specifications.

7. Hardware and Metal Surfaces: Clean and polish all exposed surfaces using non-corrosive and nonabrasive materials.

8. Glass: Wash and polish both sides, and leave free of dirt, spots, streaks, and labels. Clean and polish mirrors.

9. Ceilings: Clean and free of stains, hand marks, and defacing.

10. Replace air conditioning filters as specified in Mechanical Specifications.

11. Clean ducts, blowers and coils, if air conditioning units are found to have been operated without filters during construction, and after final inspection.

12. Lighting fixtures: Replace lamps and clean fixtures and lenses if fixtures or lamps are dirty or have smudges or dust.

13. Fixtures and Equipment: Clean and polish mechanical and electrical fixtures and like items. Leave lighting fixtures free of dust, dirt, stains or waste material. Clean and service equipment and machinery, leaving ready for use.

14. Surfaces Not Mentioned: Clean according to the intent of this Section and as required for Architect's approval.

E. Contaminated Earth: Final clean-up operation includes the removal and disposal of earth that is contaminated or unsuitable for support of plant life in planting areas, and filling the resulting excavations with suitable soil as directed and approved by the Architect, Inspector, and/or Project Manager.

Contaminated areas include those used for disposal of waste concrete, mortar, plaster, masonry, paints, and similar materials, and areas in which washing out of concrete and plaster mixers or washing of tools and like cleaning operations have been performed, and all areas and adjacent areas that have been oiled, paved, or chemically treated.

Do not dispose of waste, oil, solvents, paints, solutions, or like penetrating material by depositing or burying on School property; dispose of such material in a lawful manner.

END OF SECTION