ELECTRICAL SPECIFICATIONS

SECTION 26 05 00 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to the General Conditions, Supplementary Conditions and Division I - General Requirements, and the drawings. The Contractor, shall read the conditions and be responsible for, and governed by, all requirements there under. This Condition applies to all Sections of Specification Division 26.

B. All work and materials shall conform to Motorola Mobility Construction Standards. The contractor shall include the tenant construction standards and specifications as part of the bid. Obtain a copy from the general contractor during bidding and for reference during construction.

C. Coordinate all work with building Chief Engineer and building construction rules and regulations.

D. Furnish and install complete all materials, equipment and labor as shown and as necessary for complete workable system.

E. Contractor shall replace any fireproofing that is damaged during construction. Consult with chief engineer for most effective means of repair.

F. Contractor shall maintain the circuit integrity of existing devices to remain. Furnish and install materials as required to maintain circuits to existing devices.

1.2 CORRELATION, INTERPRETATION AND INTENT OF CONTRACT DOCUMENTS

A. It is the intent of this Specification and the Drawings to describe complete, safe, operating systems and the materials and installation work to be performed under the Contract.

B. The Contract Documents are complementary; what is called for by one is binding as if called for by all. If the Contractor finds a conflict, error or discrepancy in the Contract Documents, he shall call it to the Architect's/Engineer's attention in writing before proceeding with the work affected. Any work that may reasonably be inferred from the Specifications or Drawings as being required to produce the intended result shall be supplied whether or not it is specifically called for. Work, materials or equipment described in words which so applied have a well-known technical or trade meaning shall be deemed to refer to such recognized materials or work. The Contractor assumes full responsibility for familiarizing himself with the nature and extent of the Contract Documents, work, locality and local conditions that may in any manner affect the work to be done.

C. The Drawings are, in general, drawn to scale and the Contractor may obtain approximate distances and dimensions by scaling the Drawings. It is distinctly

understood, however, that he does so entirely on his own responsibility. The accuracy of the Drawings is not guaranteed. Refer to Architect's Drawings, Specifications and Room Schedules for construction details which will affect this work and equipment. Examine the Plumbing, Heating and Ventilating Drawings and Specifications to ensure that the Electrical work does not conflict with the above trades. Mechanical and Electrical Drawings are largely schematic and, therefore, do not necessarily represent the exact installations; it is the Contractor's responsibility to cover all conditions on his prepared Shop Drawings and by arrangement with other trades in the field.

1.3 REGULATIONS

A. The Contractor shall give required notices to the building inspectors, the Engineer and the Owner and comply with laws, ordinances, rules and regulations applicable to the work and safety. Authorities include, but are not limited to:
   1. The latest adapted revision of the State of California, Electrical Code.
   2. The applicable Rules and Regulations of the National Fire Protection Association.
   3. State Fire Marshal.
   4. The National Electrical Code.
   5. Underwriters Laboratories.
   6. Any other applicable Federal, State, County or City Codes or Regulations, including O.S.H.A.

B. Nothing in these Drawings or Specifications shall be construed to permit work not conforming to the above Regulations and Codes.

1.4 PERMITS, LAWS AND TAXES

A. The Contractor shall secure and pay for permits, licenses, inspection fees and governmental charges necessary for the completion of the work.

1.5 SAFETY AND INDEMNITY

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

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

1.6 DRAWINGS AND SPECIFICATIONS

A. Drawings and Divisions of these specifications shall be considered as a whole and work shown anywhere herein shall be furnished under this Division.

B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Exact requirements shall be governed by architectural, structural and mechanical conditions of the job. Consult other drawings in preparation of the bid.

C. Extra lengths of wiring or pull boxes or junction boxes, etc., necessitated by conditions shall be included in the bid. Report any apparent discrepancies before submitting bid.

D. Right is reserved by the Owner to make changes of up to ten feet in location of any outlet or equipment prior to roughing-in without increasing contract cost.

1.7 EXAMINATION OF SITE

A. The Contractor shall examine the site and the existing conditions and make allowances for them in preparing his proposal. In the event of discrepancies between existing conditions and the Drawings, the Contractor shall report such discrepancies prior to bid and bid the conditions necessary to complete the job and to provide a fully operable and acceptable systems.

B. Extra charges will not be allowed for work that must be provided when it was apparent from a pre-bid inspection of the premises, even though the work is not shown on the drawings or called for in the Specification.

1.8 RECORD DRAWINGS AND SYSTEM OPERATION AND MAINTENANCE

A. Submit within thirty (30) days after the date of acceptance, one (1) complete electronic file in AutoCad 2011 MEP format and one (1) complete set of vellums changed to indicate the Record of Electrical Construction. Show deviations from Contract Drawings. Show major changes only in location for any outlet, device or equipment, and hidden installations - such as feeders.

1.9 GUARANTEE

A. Materials and equipment furnished under this Specification and/or Drawings shall be guaranteed in writing for a period of one (1) year from the date of final acceptance against defective material, design and workmanship. The Contractor shall guarantee, in writing, that the systems shall be free of defects, and shall operate perfectly, and in accordance with their individual Specifications.

B. Upon receipt of notice from the Owner of failure of material, equipment or section of the system, during the guaranty period, the Contractor shall make necessary corrections promptly, without expense or inconvenience to the Owner.

PART 2 - PRODUCTS

2.1 MATERIAL APPROVAL AND SUBMITTAL

A. The design, manufacture and testing of electrical equipment and materials shall conform to or exceed latest applicable NEMA, IEEE, ANSI, and U.L. Standards.

B. Materials shall be new and bear Underwriters Laboratories (UL) label or other accepted testing laboratory certification. Materials that are not labeled by U.L. shall be tested and approved by an independent testing laboratory or a governmental agency acceptable to the Engineer, Owner and code enforcing authority.

C. Equipment, materials, and products specifically identified, described, or scheduled on the drawings and/or named first in the specifications are the basis of design. The other manufacturers or suppliers which may be named in the specification only indicate the general acceptability of the manufacturer or supplier. It is the Contractor's responsibility to research, select, and prove, through the submittal process, that the specific model, size, or type of the alternate item proposed is equal and will perform equal to that which is the basis of the design. Operational characteristics shall be considered in addition to the overall performance or output.

D. The Contractor assumes full responsibility that alternative items substituted for the first named manufacturer will meet the job requirements and is responsible for the cost of redesign and modifications necessary due to this substitution. The redesign which includes calculations and design layouts must be submitted to the Engineer for review and approval. No work involving substitution the first named manufacturer products indicated on drawings with alternative items is allowed until written approval is received from the Engineer. Revisions or additional work required due to the use of substitute materials shall be fully indicated on detailed drawings submitted with the shop drawings.

E. Mark submittal "Exactly as Specified" or accompanied by a letter from the supplier explaining in detail what difference, if any, exists between the submitted item and the specified item. Failure to point out the differences will be considered cause for disapproval. If differences are not indicated and/or not discovered during the submittal review process, the Contractor will still remain responsible for providing equipment and materials that meet the specifications.

2.2 SUBSTITUTIONS

A. Refer to General Conditions, AND:

B. A list of materials, methods and/or equipment proposed as substitutes for that specified shall be submitted to the Electrical Engineer and Owner for review. Where proposed substitutions are disapproved, the specified materials, methods and/or equipment shall be provided.

C. Contractor requested changes and substitutions shall be submitted in written form from the Contractor to the Engineer and shall be considered as authorized only upon written approval from the Engineer.

D. Items which are proposed as substitutes shall be accompanied by Drawings and/or data giving sizes, capacities and other necessary information for determining

acceptance. When Drawings are submitted to the Engineer for the purpose of showing the installation in greater detail, review of them shall not excuse the Contractor from other requirements of the Drawings or Specifications.

E. No work involving substitution materials shall proceed until written approval is received from the Engineer.

2.3 SHOP DRAWINGS AND MATERIALS LIST

A. Submittals shall be required for the following:
   1. Materials: A list identifying hardware items proposed for installation, including manufacturer's names, part numbers, finishes, colors, materials, shape and dimensions.
   2. Lighting fixtures: Catalog cuts and photometric data.
   3. Lighting control devices.
   4. Fire alarm system equipment and wiring diagrams.

2.4 OPERATING AND MAINTENANCE MANUALS

A. Submit three sets of Operating and Maintenance Manuals of equipment.

B. Operating manuals and parts list are required for the following equipment:
   1. Fire alarm system.
   2. Lighting fixtures and lighting control systems.

2.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Receive, store and handle materials in a manner to prevent damage. Costs of damage shall be borne by the Contractor.

B. Protect equipment from weather (rain, sunshine, winds), water vapors, theft, and vehicular traffic.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

A. Installation of parts and connection of parts into systems shall be completed by skilled electrical journeymen. Material assemblies and installation work shall be securely fastened to structure, attractive in appearance and safe to operate. Provide code required clearance about electrical equipment. Assembly work or installations that are improper, unsafe or unattractive shall be removed and replaced with satisfactory work at no additional cost to the Owner.

B. Provide a foreman or superintendent in charge of this work at all times.

3.2 COORDINATION

A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished by other trades. Inform other trades Sub-contractors of the required access to, and clearances around, electrical equipment to maintain serviceability and code compliance.

B. Verify equipment dimensions and requirements. Check actual job conditions before installing work. Report necessary changes in design to Architect/ Engineer /General Contractor in time to prevent needless work. Changes, or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.

C. Electrical contractor shall detail all “tight” spaces or conditions and shall coordinate work with other trades prior to ordering and installation of electrical equipment.

3.3 MANUFACTURER'S INSTRUCTIONS

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

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

3.4 QUALITY ASSURANCE

A. Provide a Quality Assurance program. These specifications set forth the minimum acceptable requirements. The specifications do not prohibit the Contractor from executing other Quality Assurance measures which can improve the operating facility, improve the construction schedule, and conserve energy within the scope of this project.

B. The Contractor shall insure that workmen's practices, materials employed, equipment and methods of installation conform to accepted construction and engineering practices, and that each piece of equipment can satisfactorily perform its functional operation.

3.5 CLOSING IN UNINSPECTED WORK

A. The Contractor shall not allow or cause any of the work to be covered up or enclosed until it has been inspected, tested and/or approved. Field observations made by the architect or engineer do not waive the inspections required by the Building Permit and performed by the local inspection authority.

B. Should a portion of the work be enclosed or covered up prior to inspection and testing, the contractor shall uncover the work at his own expense, and after it has been tested, inspected and approved, make repairs with such materials as may be necessary to restore the uncovered work to its intended condition.

3.6 PRELIMINARY OPERATION

A. Should the Owner request that a portion of the project area, apparatus or equipment be operated prior to final completion and acceptance of the work, the Contractor shall consent, and such operation shall be under the supervision and direction of the Contractor, but expense thereof shall be paid by the Owner, separate and distinct from money paid on account of the Contract. Such preliminary operation and payment thereof shall not be construed as an acceptance of that portion of the work in this Contract.

3.7 ACCEPTANCE DEMONSTRATION

A. Upon completion of work, at a time to be designated by the Engineer, the Contractor shall demonstrate for the Owner, the operation of the electrical installation, including any and all special items installed by him or installed under his supervision. A minimum of four (4) hours of time for each electrical system must be allowed for this purpose.

B. The system demonstrations shall be made by this Contractor in the presence of the Owner's plant facilities manager or his designated representative and the manufacturer's representative.

3.8 TESTS

A. Where the Contract Documents, laws, ordinances or any public authority requires any work to be tested specifically or reviewed by another authority, the Contractor shall give the Engineer/Owner timely notice of readiness therefore. The Contractor shall give the Engineer/Owner the test results for review. If any work to be tested is covered up without written approval or consent of the Architect, it must, if directed by the Architect, be uncovered for examination at the Contractor's expense.

B. The cost of all such tests shall be borne by the Contractor.

C. Any work which fails to meet the requirements of any test or any work which does not meet the requirements of the Contract Documents shall be considered defective and may be rejected. Rejected work shall be corrected promptly by the Contractor or removed from the site.

D. Provide written test reports for each test to the Engineer for review.

END OF SECTION 26 05 00

SECTION 26 05 01 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

B. Supporting devices for electrical components.

C. Electrical demolition.

D. Cutting and patching for electrical construction.

E. Touchup painting.

1.3 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

B. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

C. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

D. Coordinate electrical service connections to components furnished by utility companies.

E. Coordinate installation and connection of exterior underground services, including provision for electricity-metering components.

F. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

G. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch diameter slotted holes at a maximum of 2 inches o.c., in webs.

D. Channel Thickness: Selected to suit structural loading.

E. Fittings and Accessories: Products of the same manufacturer as channel supports.

F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

H. Expansion Anchors: Carbon-steel wedge or sleeve type.

I. Toggle Bolts: All-steel springhead type.

2.2 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumbing, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four (4) minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze or bracket-type hangers.

D. Size supports for multiple raceway installations, so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceways with an approved fastener not more than 24-inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

N. Wood: Fasten with wood screws or screw-type nails.

O. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.

P. New Concrete: Concrete inserts with machine screws and bolts.

Q. Existing Concrete: Expansion bolts.

R. Steel: Welded threaded studs or spring-tension clamps on steel.
1. Field Welding: Comply with AWS D1.1.

S. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.

T. Light Steel: Sheet-metal screws.

U. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Life Division Safety.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 033000 Section "Cast-in-Place Concrete."

3.6 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway, indicated to be abandoned in place, 2-inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish. Remove all wire.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

B. Supporting devices for electrical components.

C. Electrical demolition.

D. Cutting and patching for electrical construction.

E. Touchup painting.

3.9 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touchup paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

B. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

C. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

D. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

E. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.10 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations, and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 26 05 01

SECTION 26 05 19 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 QUALITY ASSURANCE

~~A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.~~

~~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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 CONDUCTORS AND CABLES

A. Manufacturers:
   1. Alcan Aluminum Corporation; Alcan Cable Div.
   2. American Insulated Wire Corp.; a Leviton Company.
   3. General Cable Corporation.
   4. Southwire Company.
   5. Okonite.

B. Conductor Material: Copper; stranded Class B conductor.

C. Conductor Insulation Types: Type THHN-THWN, XHHWN-2. Type XHHNWN-2 shall be used for feeders and branch circuits larger than #2AWG.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Push-wire connectors are not acceptable.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Feeders: Type THHN-THWN, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN**,** single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

D. Exposed Branch Circuits: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

G. Fire Alarm Circuits: Type THHN-THWN, in raceway or power-limited, fire-protective, signaling circuit cable.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."

F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

G. Identify and color-code conductors and cables according to Division 26 Section “Electrical Identification.”

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6-inches of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
   1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
   2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:
   1. Division 26 Section “Conductors and Cables.”
   2. Division 26 Section “Raceways and Boxes.”

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

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.
   1. Comply with UL 467.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. A.Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grounding Conductors, Cables, Connectors, and Rods:
      a. Apache Grounding/Erico Inc.
      b. Chance/Hubbell.
      c. Copperweld Corp.
      d. Erico Inc.; Electrical Products Group.
      e. Framatome Connectors/Burndy Electrical.

f. Ideal Industries, Inc.
g. ILSCO.
h. Kearney/Cooper Power Systems.
i. Korns: C. C. Korns Co.; Division of Robroy Industries.
j. O-Z/Gedney Co.; a business of the EGS Electrical Group.
k. Raco, Inc.; Division of Hubbell.
l. Superior Grounding Systems, Inc.
m. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:
1. Assembly of Stranded Conductors: ASTM B 8.
2. Tinned Conductors: ASTM B 33.

H. Copper Bonding Conductors: As follows:
1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators. Provide on ground bus in each IDF and MDF room connected to the nearest building beam bus size 4” W X 18”L X ¼”. See detail on drawings.) Connect to building with #1/0 Cu. CadWeld to structural steel. (re-fireproof after installation)

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Use insulated spacer; space 1-inch from wall and support from wall 18-inches above finished floor in electrical room and 84-inch A.F.F. in telecom rooms, unless otherwise indicated.

F. Underground Grounding Conductors: Use tinned-copper conductor, No. 2/0 AWG minimum. Bury at least 24-inches below grade.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

F. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

G. Water Heater and Heat-Tracing: Install a separate equipment grounding conductor to each electric water heater or heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

H. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

A. Ground Rods: Install rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
   1. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

END OF SECTION 26 02 56

SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 26 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
   2. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. LFNC: Liquidtight flexible nonmetallic conduit.

F. RNC: Rigid nonmetallic conduit.

1.4 QUALITY ASSURANCE

A. 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.

B. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube and Conduit.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
7. LTV Steel Tubular Products Company.
8. Manhattan/CDT/Cole-Flex.
9. O-Z Gedney; Unit of General Signal.
10. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

E. Plastic-Coated IMC and Fittings: NEMA RN 1.

F. EMT and Fittings: ANSI C80.3.
1. Fittings: Compression type.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:
1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe & Plastics Group.
6. Condux International.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.
13. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

E. LFNC: UL 1660.

2.4 METAL WIREWAYS

A. Manufacturers:
1. Hoffman.
2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

1. Manufacturers:
   a. Thomas & Betts Corporation.
   b. Walker Systems, Inc.; Wiremold Company (The).
   c. Wiremold Company (The); Electrical Sales Division.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. Emerson/General Signal; Appleton Electric Company.
   3. Erickson Electrical Equipment Co.
   4. Hoffman.
   5. Hubbell, Inc.; Killark Electric Manufacturing Co.
   6. O-Z/Gedney; Unit of General Signal.
   7. RACO; Division of Hubbell, Inc.
   8. Robroy Industries, Inc.; Enclosure Division.
   9. Scott Fetzer Co.; Adalet-PLM Division.
   10. Spring City Electrical Manufacturing Co.
   11. Thomas & Betts Corporation.
   12. Walker Systems, Inc.; Wiremold Company (The).
   13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Floor Boxes: Multi-service, stamped steel, fully adjustable, rectangular, FSR Series Q.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.7 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:
   1. Exposed: Rigid steel or IMC.
   2. Concealed: Rigid steel or IMC.
   3. Underground, Single Run: RNC.
   4. Underground, Grouped: RNC.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   6. Boxes and Enclosures: NEMA 250, Type 3R, minimum or as noted.

B. Indoors:
   1. Exposed: EMT.
   2. Exposed subject to physical damage: Rigid steel.
   3. Concealed: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
   5. Damp or Wet Locations: EMT with water-tight connectors.
   6. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
      a. Damp or Wet Locations: NEMA 250, Type 4.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

3.2 INSTALLATION

A. Keep raceways at least 6-inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."

D. Install temporary closures to prevent foreign matter from entering raceways.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2-inches of concrete cover.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   2. Space raceways laterally to prevent voids in concrete.
   3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J. Join raceways with fittings designed and approved for that purpose and make joints tight.

K. Tighten set screws of threadless fittings with suitable tools.

L. Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12-inches of slack at each end of pull wire.

N. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6-inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

Q. Flexible Connections: Use maximum of 72-inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

R. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

S. Set floor boxes level and flush with finished floor surface.

T. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 05 33

SECTION 26 05 48 - SEISMIC CONTROLS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes seismic restraints and other earthquake-damage-reduction measures for electrical components. It complements optional seismic construction requirements in the various electrical component Sections.

1.3 DEFINITIONS

A. UBC: Uniform Building Code.

B. Seismic Restraint: A fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.

C. Mobile Structural Element: A part of the building structure such as a slab, floor structure, roof structure, or wall that may move independent of other mobile structural elements during an earthquake.

D. Coordination Drawings: Plans and sections drawn to scale and coordinating seismic bracing for electrical components with other systems and equipment, including other seismic restraints, in the vicinity.

E. Product Certificates: Signed by manufacturers of seismic restraints certifying that products furnished comply with requirements.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

G. Material Test Reports: From a qualified testing agency indicating and interpreting test results of seismic control devices for compliance with requirements indicated.

1.4 QUALITY ASSURANCE

A. Comply with seismic restraint requirements in UBC, unless requirements in this Section are more stringent.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing seismic engineering services, including the design of seismic restraints, that are similar to those indicated for this Project.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.

1.5 SEISMIC DESIGN CRITERIA

A. Nonstructural Systems – Seismic Design Forces
1. Nonstructural Systems – Seismic Design Forces shall comply with Section 1632 of the 1997 UBC for forces determined from formula (32-2) using a value of Ip = 1.0, Na = 1.06, Nv = 1.33, Ca = 0.44Na. For the Hazardous facilities Group H, Division 1, 2, 6, and 7 the value of Ip = 1.5 shall be used. For anchorage of machinery and equipment required for life safety systems, the value of Ip shall be taken as 1.5.

B. Nonstructural System – Wind Design Forces
1. Nonstructural System Wind Design Forces shall comply with 1997 UBC. For the Hazardous facilities Group H, Division 1, 2, 6, and 7 the value of Ip = 1.15 shall be used.

C. Nonstructural Systems – Detailing

1. For seismic bracing of suspended systems, the contractors and specialty engineers shall prepare a coordinated drawing showing all suspended items and the required bracing elements, including reaction force at each hanger and bracing.
2. The drawings and specifications shall include all necessary details for seismic anchorage and restraint of nonstructural systems.

D. Nonstructural Systems – Review and Approval

1. Calculations, drawings with plans and details for seismic anchorage and restraint of nonstructural systems (developed by contractors and specialty engineers) shall be reviewed for conformity to the design criteria by the Engineer of Record prior to construction.

E. Nonstructural Systems

1. Suspended Loads:

a. All loads suspended shall be from the W12 beams or Girders shall have seismic bracing designed to the requirement of Section A. This includes, but is not limited to, ducts, piping, conduits, cables, and cable trays. This bracing shall be designed by a licensed structural engineer in the State of California and shall be submitted to Alfa Tech, Inc. for acceptance.

b. Bracing shall be connected and run in the same direction of the member to which it is connected. Braces shall be connected to main structural member W12 beams. Connection of the brace is to be made such that the force transmitted is directed parallel to the member with which the brace connect. If the brace is orthogonal to the W12 beams, it shall be located at the panel points of the girder or at the mid-span of the beam. The beam top flange is braced at mid-span. The brace shall be connected to the top flange or to wood member that is at least 4X member blocking that is connected to the roof sheathing (plywood). All braces should be designed to prevent torsion to the beams through the use of additional blocking, bracing or other means. The maximum total load to the beam weak axes shall be less than 400# along the entire beam.

c. The total vertical suspended load on any w12 beams shall not exceed 2,000 lbs.

2. Floor Mounted Equipment: Any floor-mounted equipment requiring seismic bracing is to be braced or anchored to the concrete slab on grade, not to the steel structure above.

3. Other Roof Mounted Items: Only sleepers that are supported by the new W12 beams shall support all roof-mounted items. OWJ shall not be used to support any item without the engineer approval.

F. Construction Inspection: All construction shall be inspected by the specialty engineer for compliance with the design drawings and specifications.

1.6 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-Line Systems, Inc.
2. Erico, Inc.
3. GS Metals Corp.
4. Mason Industries, Inc,
5. Powerstrut.
6. Thomas & Betts Corp.
7. Unistrut Corporation.

2.2 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.3 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.4 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

1. Materials for Channel: ASTM A 570, GR 33.
2. Materials for Fittings and Accessories: ASTM A 575, ASTM A 576, or ASTM A 36.
3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.

1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
2. Wire Rope Cable: Comply with ASTM 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.

D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod longer than 3’.

PART 3 - EXECUTION

3.1 APPLICATION

A. Generator Sets: Comply with Section 26____.

3.2 INSTALLATION

A. Install seismic restraints according to applicable codes and regulations and as approved by authorities having jurisdiction, unless more stringent requirements are indicated.

3.3 STRUCTURAL ATTACHMENTS

A. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.

B. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.

C. Attachments to Existing Concrete: Use expansion anchors.

D. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.

E. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.

F. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.

G. Attachments to Wood Structural Members: Install bolts through members.

H. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

3.4 ELECTRICAL EQUIPMENT ANCHORAGE

A. Anchor panelboards, motor-control centers, motor controls, switchboards, switchgear, transformers, fused power-circuit devices, transfer switches, communication system components, and electronic signal processing, control, and distribution units as follows:
   1. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
   2. Concrete Bases for Floor-Mounted Equipment: Use female expansion anchors and install studs and nuts after equipment is positioned.
   3. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.

4. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
5. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

3.5 SEISMIC BRACING INSTALLATION

A. Install bracing according to spacings and strengths indicated by approved analysis.

B. Expansion and Contraction: Install to allow for thermal movement of braced components.

C. Cable Braces: Install with maximum cable slack recommended by manufacturer.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to the structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Make flexible connections in raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform the following field quality-control testing:
   1. Provide necessary test equipment required for reliable testing.
   2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   3. Schedule test with Owner, through Engineer, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
   4. Obtain Architect's approval before transmitting test loads to the structure. Provide temporary load-spreading members.
   5. Test at least two of each type and size of installed anchors and fasteners selected by the Engineer.
   6. Test to 90 percent of rated proof load of device.
   7. If a device fails the test, modify all installations of same type and retest until satisfactory results are achieved.
   8. Record test results.

END OF SECTION 26 05 48

SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
   1. Color: Black letters on white field.
   2. Legend: Indicates voltage and service.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend over laminated with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

E. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Nameplates: Engraving stock, phenolic plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters not less than 1/8 inch height on white face.
2. Punched or drilled for mechanical fasteners.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with black letters on white face and size required for the application. 1/4-inch grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with black letters on white face and size required for the application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Nameplates and Signs: No. 10/32, stainless-steel machine screws with nuts and flat and lock washers for signs, and either screws or double faced pressure sensitive tape for nameplates.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: According to color-coding.

B. Paint: Formulated for the type of surface and intended use.
1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Install painted identification according to manufacturer's written instructions and as follows:
   1. Clean surfaces of dust, loose material, and oily films before painting.
   2. Prime surfaces using type of primer specified for surface.
   3. Apply one intermediate and one finish coat of enamel.

F. Caution Labels for Indoor Pull Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on white background. Install on exterior of door or cover. On Junction Boxes, mark panel and circuit number on inside of blank box cover with black indelible marker.

G. In buildings with two distribution voltages (480/277V and 208/120V), all panels shall have a nameplate to identify the wire color used with each phase and neutral. Nameplate shall be inside of panel door. Use the following colors for phase conductors:
   1. 208/120-V Conductors:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Neutral: White
      e. Ground: Green.
      f. Isolated Ground: Green with yellow tracer.

   2. 480/277-V Conductors:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Light Grey.
      e. Equipment Ground: Green.
   3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG.
      a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
      b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

H. Raceway Identification: All exposed electrical and systems conduit shall be labeled at each junction box, at each panel, at twenty (20) feet intervals. Labels shall be “Snap-on Electrical Marker” by Seton Identification Products (1-800-571-2596). Labels to include, but not limited to: “CONTROL”, “DATA HIGHWAY”, “INSTRUMENTATION”, “FIRE ALARM”, “SECURITY”, “CCTV”, “POWER 120/208v”, etc.

I. Apply identification to conductors as follows:
   1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

J. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

K. Equipment Identification Labels: Engraved plastic laminate.
1. Install nameplate for all branch circuit disconnect means per NEC 110.22 and for all motor controls, where control stations are immediately adjacent to motor being controlled.
2. Nameplates for MCCs shall be factory-furnished with equipment.
3. Panelboards shall have nameplates on the outside of door. Type panelboard index cards to comply with working indicated on drawing panelboard schedules. Do not type “spaces” or “spares” on index card. Provide arc flash hazard warning labels on the panel enclosures,

L. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Use black lettering on white field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Main nameplates for switchgear, switchboards, panels and MCCs shall have the following engraving:

ULine No.U	UContentsU	UExample
1	Equipment Identification	MCCA
2	Rating	1200A, 480V
3	Upstream Disconnect	from SWBDA-3
4	Room No. of Source	2201

2. Switchgear and switchboard individually mounted breakers/switches (not in panel construction) shall have nameplates with the following engraving:

ULine No.U	UContentsU	UExample
1	Equipment Fed	MCCA
2	Rating	1200A, 480V
3	Upstream Disconnect	from SWBDA-3
4	Room No. of Load	2200

3. Nameplates of MCC buckets shall have the following engraving:

Line No.	Contents	Example
1	Equipment	0782P12
2	Equipment Description	WFI CIRC PUMP
3	Room No. of Load	2200

4. Nameplates on local control stations and disconnects shall give the following engraving:

Line No.	Contents	Example
1	Tag Number	P-930.1
2	Equipment Description	WFI CIRC PUMP
3	Upstream Disconnect	MCCA-3F
4	Room No. of Source	2200

5. Nameplates of receptacles shall be centered above the receptacle and shall have the following engraving:

Line No.	Contents	Example
1	Panel #, Circuit # feeding the receptacle	EL121-3

6. In buildings with two distribution voltages (480/277V and 208/120V), all panels shall have a nameplate to identify the wire color used with each phase and neutral. Nameplate shall be inside of panel door.

3.2 MARKING

A. Mark panel and circuit numbers on the inside of blank box covers with a black indelible marker.

END OF SECTION 26 05 53

SECTION 26 05 73 - SHORT-CIRCUIT ANALYSIS AND COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a complete short circuit study, equipment interrupting or withstand evaluation, and a protective device coordination study for the electrical distribution system.

B. The study to include all portions of the electrical distribution system from the normal and alternate sources of power. Include all portions of the low voltage distribution systems as specified in this Section.

C. Study Basis: Thoroughly cover all normal or alternate operation modes that could produce maximum fault conditions.

1.2 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code (NEC 2005) with California State amendments (California Electrical Code – CEC 2007).

B. IEEE - Institute of Electronic and Electrical Engineers.

C. ANSI - American National Standard Institute.

1.3 QUALITY ASSURANCE

A. Study preparation by a registered electrical engineer, State of California.

B. Study based on the actual equipment and devices selected for the project.

C. Adhere to CEC requirements.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 SHORT-CIRCUIT STUDY

A. Perform study in accordance with applicable ANSI/IEEE Standards.

B. Study Input Data:
   1. Utility company's short-circuit 1 and 2 phase contribution and the X/R ratio.

2. Resistance and reactance components of each feeder and branch impedance.
3. Motor and generator contributions.
4. All other applicable circuit parameters that contribute to the short-circuit duty.

C. Calculate the short-circuit momentary duties and interrupting duties on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.

3.2 EQUIPMENT EVALUATION STUDY

A. Perform an equipment evaluation study to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short-circuit ratings of these devices with the available fault currents.

B. Notify the IOR and General Contractor, in writing, about any problem areas or inadequacies in the equipment.

3.3 PROTECTIVE DEVICE COORDINATION STUDY

A. Perform a coordination study to select or check the selections of the following protective devices and components:
1. Power fuse ratings.
2. Protective relay characteristics and settings.
3. Ratios and characteristics of associated voltage and current transformers.
4. Low voltage breaker trip characteristics and settings.

B. Provide a coordination study that covers all voltage classes of equipment from the utility's incoming line protective device down to following:
1. Low voltage switchboards.
2. 480Y/277 and 208Y/120 volt distribution panels.
3. 480Y/277 and 208Y/120 volt panelboards.

C. Plot time-current characteristics of the specified protective devices using log-log paper. Include the following minimum information, as pertinent to system, on plots:
1. Complete titles.
2. Representation 1 line diagram and legends.
3. Power company's relays or fuse characteristics.
4. Significant motor starting characteristics.
5. Complete transformer parameters; include ANSI inrush and withstand curves.
6. Complete operating bands of low voltage circuit breaker trip curves.
7. Fuse curves.
8. Protective relay type selected and curves.
9. Cable damage curves.
10. Symmetrical and asymmetrical fault currents.

D. Maintain reasonable coordination intervals and separation of characteristic curves on plots.

E. Make coordination plots for phase and ground protective devices on a complete system basis.

F. Provide sufficient curves to clearly indicate the coordination achieved to each utility main breaker, and load protective device rated 250 amperes or more.

G. A maximum of 8 protective devices are permitted for each plot.

H. Provide a separate tabulated list for the selection and settings of the protective devices. Include the following minimum information:
1. Circuit identification.
2. IEEE device number.
3. Current transformer ratios.
4. Manufacturer, device type and range of adjustment.
5. Recommended settings.

I. Notify the Engineer and General Contractor, in writing, about system discrepancies, problem areas or inadequacies.

3.4 STUDY REPORT

A. Summarized the results of the power system study in 1 bound final report.

B. Organize the report using the following sections:
1. Description, purpose, basis, written scope, and a single-line diagram of the portion of the power system which is included within the scope of study.
2. Tabulations of circuit breaker, fuse, and other equipment ratings versus calculated short-circuit duties, and commentary regarding same.
3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
4. Fault current tabulations including a definition of terms and a guide for interpretation.

3.5 IMPLEMENTATION

A. An independent testing firm will set, test, and calibrate protective devices in accordance to the final approved Study Report.

END OF SECTION

SECTION 26 05 74 - ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:
   1. Qualifications of testing agencies and their personnel.
   2. Suitability of test equipment.
   3. Calibration of test instruments.
   4. Coordination requirements for testing and inspecting.
   5. Reporting requirements for testing and inspecting.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: As specified in each Section containing electrical testing requirements and in subparagraph and associated subparagraph below.
   1. Independent Testing Agencies: Independent of manufacturers, suppliers, and installers of components to be tested or inspected.
      a. Testing Agency's Field Supervisor for Power Component Testing: Person currently certified by the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Division 16 power component Sections.

B. Test Equipment Suitability: Comply with NETA Acceptance Testing Specifications (ATS), Section 5.2.

C. Test Equipment Calibration: Comply with NETA Acceptance Testing Specifications (ATS), Section 5.3.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 GENERAL TESTS AND INSPECTIONS

A. If a group of tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:
   1. Perform insulation-resistance tests.
   2. Perform continuity tests.
   3. Perform rotation test (for motors to be tested).
   4. Provide a stable source of single-phase, 208/120-V electrical power for test instrumentation at each test location.

B. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:
   1. Manufacturer's written testing and inspecting instructions.
   2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
   3. Tabulation of expected measurement results made before measurements.
   4. Tabulation of "as-found" and "as-left" measurement and observation results.

END OF SECTION 26 05 74

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

B. Related Sections include the following:
   1. Division 26 Section "Lighting Controls" for low-voltage, manual and programmable lighting control systems.
   2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control devices from a single source with total responsibility for compatibility of lighting control system components specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use and installation conditions by a testing agency acceptable to authorities having jurisdiction.

C. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Contactors and Relays:
      a. Wattstopper (Landlord Standard). No substitution allowed.
   2. Time Switches:
      a. Not required.

3. Occupancy Sensors:
   a. Wattstopper (Landlord Standard). No substitution allowed.

2.2 OCCUPANCY SENSORS

A. Ceiling-Mounting Units: Unit receives control power from a separately mounted auxiliary power and control unit, and operates power switching contacts in that unit.

B. Switch-Box-Mounting Units: Unit receives power directly from switch leg of the 120- or 277-V ac circuit it controls and operates integral power switching contacts rated 800 W at 120-V ac, and 1000 W at 277-V ac, minimum.

C. Operation: Turns lights on when room or covered area is occupied and off when unoccupied, unless otherwise indicated.
   1. Time Delay for Turning Lights Off: Adjustable over a range from 1 to 15 minutes, minimum.
   2. Manual Override Switch: Turns lights off manually regardless of elapsed time delay.

D. Auxiliary Power and Control Units: As follows:
   1. Relays rated for a minimum of 20-A normal ballast load or 13-A tungsten filament or high-inrush ballast load.
   2. Sensor Power Supply: Rated to supply the number of connected sensors.

E. Dual-Technology Type: Uses a combination of passive-infrared and ultrasonic detection methods to distinguish between occupied and unoccupied conditions for area covered. Particular technology or combination of technologies that controls each function (on or off) is selectable in the field by operating controls on unit.

2.3 MULTIPOLE CONTACTORS AND RELAYS

A. Description: Electrically operated and mechanically held, and complying with UL 508 and NEMA ICS 2.
   1. Current Rating for Switching: UL listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballasts with 15 percent or less total harmonic distortion of normal load current).
   2. Control Coil Voltage: Match control power source.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Mount lighting control devices according to manufacturer's written instructions and requirements in Division 26 Section "Basic Electrical Materials and Methods."

C. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 26 Section "Conductors and Cables" for low-voltage connections.

B. Wiring Method: Install all wiring in raceway as specified in Division 26 Section "Raceways and Boxes."

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

3.4 FIELD QUALITY CONTROL

A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

B. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

C. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

D. Verify settings of photoelectric devices with photometer calibrated within previous six months.

E. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:
   1. Continuity tests of circuits.
   2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
      a. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
   1. Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of three hours' training.
   2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
   3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 26 09 23

SECTION 26 22 00 - DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Copper-wound transformer optimized for light loading, meeting US Department of Energy proposed Candidate Standard Level (CSL) 3 efficiency, extremely low no load losses, with optional integrated efficiency and power quality meter.

B. Load Mix: Transformer shall be UL listed to feed a mix of equipment load profiles such as computers without derating or significant degradation of efficiency.

C. Comply with Section 26 05 00 of this specification.

1.2 REFERENCES

A. NEMA Standard Published Nos. TR 1 and TR 27 pertaining to power/distribution transformers.

B. NEMA ST 20 - Dry-Type Transformers for General Applications.

C. NFPA-70, National Electrical Code - 2005 with State of California Amendments ("California Electrical Code," "CEC - 2007")

D. International Building Code with State of California Amendments (“California Building Code,” “CBC – 2007”)

E. ANSI/UL 506; “Safety Standard for Specialty Transformers.”

1.3 SUBMITTALS

A. Comply with provisions of Division 01 specifications for SUBMITTALS.

B. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Division 01 specifications for MATERIALS AND EQUIPMENT: Transport, handle, store, and protect products.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.6 WARRANTY

A. Transformer shall carry a 25-year pro-rated warranty, which shall be standard for the product line.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, manufacturer offering products which may be incorporated in the work include the following:
   1. Powersmiths International Corp.

B. Substitutions are permitted, subject to meeting all the requirements of this specification and having written approval by engineer 15 days prior to bid closing. Substitutions after bid closing are not acceptable.

2.2 TRANSFORMER SPECIFICATION

A. Compatibility: This product must facilitate the ability of the electrical system to supply a sinusoidal voltage in order to improve the long-term compatibility of the electrical system with all types of linear and nonlinear connected loads today and in the future. All national and international standards on harmonics and power quality set limits on levels of voltage distortion to maintain compatibility.

B. Copper-wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to NEMA ST20 and relevant NEMA, UL and IEEE standards; 200% rated neutral; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be U.L. and CSA Listed and bear the label. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL.

C. Insulation System:
   1. Shall be NOMEX-based with an Epoxy Co-polymer impregnant for lowest environmental impact, long term reliability and long life expectancy.

2. Class: 220 degrees C.
3. Impregnant Properties for low emissions during manufacturing, highest reliability and life expectancy.
4. Epoxy co-polymer.
5. VOC: less than 1.65 lbs/gal (low emissions during manufacturing).
6. Water absorption (24hrs @25C): less than 0.05% (superior insulation, longer life).
7. Chemical Resistance: Must have documented excellent performance rating by supplier.
8. Dielectric Strength: minimum of 3200 volts/mil dry (for superior stress, overvoltage tolerance).
9. Dissipation Factor: max. 0.02 @25C to reduce aging of insulation, extending useful life.

D. Operating Temperature Rise: 105 degree C in a 40 degree C maximum ambient..

E. Voltage Taps: For transformers 30kVA-300kVA, provide two 2-1/2% full capacity taps above and below nominal primary voltage. For transformers 15kVA and smaller as well as 500kVA and larger provide one 5% full capacity tap above and below nominal primary voltage.

F. Sound Levels: NEMA ST 20.

G. Maximum No Load Losses:
   1. Transformers are energized 24 hours a day for their entire life, potentially 40 years or more. These losses are incurred whether the transformer is loaded or not, and cost the user many times the purchase price of the transformer even at current energy rates.
   2. No load losses shall not exceed: 15kVA: 50W, 30kVA: 90W, 45kVA: 120W, 75kVA: 170W, 112.5kVA: 250W, 150kVA: 310W, 225kVA: 430W, 300kVA: 530W, 500kVA: 800W.

H. F. UL Listed & Labeled K-Rating: K-13 or higher.

I. Mounting:
   1. 1-15 kVA: Suitable for wall mounting.
   2. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
   3. Larger than 75 kVA: Suitable for floor mounting.

J. Enclosure type: NEMA 2, drip-proof.

K. Efficiency at 15% loading:
   1. Data shows that transformers are typically very lightly loaded for extended periods of time, therefore to minimize operating cost under real world loading conditions, efficiency at 1/6 loading shall be maximized.
   2. Efficiency at 1/6 load shall meet or exceed: 15kVA: 97.3%, 30kVA: 97.6%, 45kVA: 97.9%, 75kVA: 98.2%, 112.5kVA: 98.4%, 150kVA: 98.5%, 225kVA: 98.6%, 300kVA: 98.7%, 500kVA: 98.8%, 750kVA: 98.9%.

L. Nameplate: Include transformer connection data [and overload capacity based on rated allowable temperature rise].

M. DOE 10 CFR Part 430 CSL 3 Efficiency requirement, tested per NEMA TP-2:
   1. Shall meet or exceed: 15kVA: 97.6%, 30kVA: 98.1%, 45kVA: 98.3%, 75kVA: 98.6%, 112.5kVA: 98.8%, 150kVA: 98.9%, 225kVA: 98.9%, 300kVA: 99.0%, 500kVA: 99.1%, 750kVA: 99.2%.

N. Efficiency under k-7 nonlinear load at 50% of nameplate rating:
   1. 15kVA: 97.3%, 30kVA: 97.7%, 45kVA: 97.9%, 75kVA: 98.4%, 112.5kVA: 98.7%, 150kVA: 98.8%, 225kVA: 98.8%, 300kVA: 98.8%, 500kVA: 98.9%, 750kVA: 98.9%.

O. Impedance: Between 3.5% and 5.8% unless otherwise noted.

P. Maximum Footprint for 130 degree C rise model in a NEMA 1 enclosure:
   1. 17” Wide x 17” Deep x 27” High for 15kva.
   2. 26” Wide x 18” Deep x 30” High for 30kVA, 45kVA.
   3. 33” Wide x 22” Deep x 40” High for 75kVA, 112.5kVA.
   4. 38” Wide x 28” Deep x 52” High for 150kVA.
   5. 38” Wide x 32” Deep x 52” High for 225kVA, 300kVA.
   6. 52” Wide x 38” Deep x 61” High for 500kVA.
   7. 63” Wide x 46” Deep x 67” High for 750kVA.

Q. Demonstrate compliance by providing factory production test report for every unit on this project upon shipment to customer or customer representative.

R. Lug Kit: Supply with standard screw-type lugs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, under the provisions of Section 16130 – CONDUIT AND FITTING, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

D. Mount floor-mounted transformers on vibration isolating pads suitable for isolating and transformer noise from the building structure. Install pads under the entire length of the transformer support channel. Installing short isolation pad pieces at transformer channel corner points is not acceptable.

E. Mount trapeze-mounted transformers as indicated, otherwise floor mount.

F. Provide seismic restraints in accordance with Uniform Building Code requirements.

G. Provide grounding and bonding in accordance with Section 26 05 20 - GROUNDING AND BONDING.

3.2 ADJUSTING

A. Refer to Division 01 specifications for CONTRACT CLOSEOUT: Adjusting installed work.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

3.3 CLEANING

A. Refer to Division 01 specifications for CLEANING.

B. Touch up scratched or marred surfaces to match original finish.

C. Thoroughly wipe dirt and dust from devices and components. Vacuum equipment interior after cleaning devices.

3.4 EQUIPMENT ENERGIZING

A. Clean and test equipment before energizing.

B. Maintain locked, clean and dust free premise for energized equipment.

3.5 COMMISSIONING

A. Refer to Division 01 specifications for BUILDING SYSTEMS COMMISSIONING.

3.6 TESTING

A. Refer to Section 26 05 73 - SHORT CIRCUIT ANALYSIS AND COORDINATION STUDY and 16080 - TESTING REQUIREMENTS, for system testing requirements.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

A. SUMMARY (Existing Base building System is Eaton.)

B. Distribution panelboards Eaton.

C. Branch circuit panelboards Eaton .

D. Comply with Section 26 05 00 of this specification.

1.2 REFERENCES

A. NECA Standard of Installation (published by the National Electrical Contractors Association).

B. NEMA AB1 - Molded Case Circuit Breakers.

C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

D. NEMA PB 1 - Panelboards.

E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

F. NFPA-70, National Electrical Code - 2005 with State of California Amendments ("California Electrical Code," "CEC - 2007")

G. International Building Code with State of California Amendments (“California Building Code,” “CBC – 2007”)

1.3 SUBMITTALS

A. Comply with provisions of Division 01 specifications for SUBMITTAL PROCEDURES.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

1.4 SUBMITTALS FOR CLOSEOUT

A. Refer to Division 01 specifications for OPERATING AND MAINTENANCE DATA: Submittals for project closeout.

B. Record actual locations of panelboards and record actual circuiting arrangements in project record documents.

C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALITY ASSURANCE

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

1.6 MAINTENANCE MATERIALS

A. Refer to Division 01 specifications for CLOSEOUT PROCEDURES.

B. Furnish two of each panelboard key.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Eaton Cutler-Hammer

2.2 DISTRIBUTION PANELBOARDS

A. Description: NEMA PB 1, circuit breaker type.

B. Panelboard Bus 1200 ampere and larger: Copper or tin plated aluminum, ratings as indicated. Provide copper ground bus in each panelboard.

C. Panelboard Bus smaller than 1200 ampere: Copper,ratings as indicated. Provide copper ground bus in each panelboard.

D. Minimum integrated short circuit rating: Final rating based on the short circuit study completed under provisions of Section 26 05 73 - SHORT-CIRCUIT ANALYSIS AND COORDINATION STUDY.

E. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

F. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

G. Enclosure: NEMA PB 1, Type 1 or 3R as indicated on the drawings, 6 inches deep, 20 inches wide, cabinet box.

H. Cabinet Front: Surface type, fastened with hinge and latch, finish in manufacturer's standard grey enamel.

I. Cabinet Locks: Provide flush-type cylinder locks and latches. Use Corbin Lock with Cat. 60 key or Yale No. 2446 lock.

J. Future provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

2.3 BRANCH CIRCUIT PANELBOARDS

A. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

B. Panelboard Bus: Copper ratings as indicated. Provide copper ground bus in each panelboard[; provide insulated ground bus where scheduled].

C. Minimum Integrated Short Circuit Rating: Final rating based on the short circuit study completed under provisions of Section 26 05 73 - SHORT-CIRCUIT ANALYSIS AND COORDINATION STUDY.

D. Provide 173% rated neutral bussing.

E. Molded Case Circuit Breakers: NEMA AB1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground Fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.

F. Enclosure: NEMA PB 1, Type 1 or 3R as indicated on the drawings.

G. Cabinet Box: 6 inches (153 mm) deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards

H. Cabinet Front: Provide flush or surface mounting as shown on the schedules, drawings or otherwise indicated. Provide concealed hinged front cover, door-in-door construction, and metal directory holder with heavy clear plastic protector. Finish in manufacturer's standard gray enamel.

I. Multi-Panel assembly similar to item H with panelboards arrange in 84-pole single box or 4-42pole panels in a common box stacked one above the other.

J. Cabinet Locks: Provide flush-type cylinder locks and latches. Use Corbin Lock with Cat. 60 key or Yale No. 2446 lock.

K. Equip panelboards with main circuit breakers unless otherwise noted on the schedules or drawings.

L. Furnish surface mounted cabinet boxes without knockouts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

F. Provide engraved plastic nameplates under the provisions of Section 26 05 53 - ELECTRICAL IDENTIFICATION.

G. Provide spare conduits out of each recessed panelboard to an accessible location. Minimum spare conduits:

H. Ground and bond panelboard enclosure according to Section 26 05 26 - GROUNDING AND BONDING.

I. Neatly train and bundle wires using nylon ties.

3.2 SEISMIC MOUNTING

A. Install equipment in accordance with the earthquake regulations of the Uniform Building Code and any amendments of building code enforcement agency having jurisdiction.

3.3 ADJUSTING

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

3.4 CLEANING

A. Comply with requirements of Division 01 specifications for CLEANING.

B. Touch up scratched or marred surfaces to match original finish.

C. Thoroughly wipe dirt and dust from devices and components. Vacuum equipment interior after cleaning devices.

3.5 EQUIPMENT ENERGIZING

A. Clean and test equipment before energizing.

B. Maintain locked, clean and dust free premise for energized equipment.

3.6 TESTING

A. Commission per manufacturer's recommendations. Panelboards shall match existing base building type.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes receptacles, connectors, switches, and finish plates.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

1.4 SUBMITTALS

A. Product Data: Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NEMA WD 1.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-furnished equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Switches, receptacles and cover plates:
    a. Hubbell
    b. Pass & Seymour
    c. Leviton.
2. Occupancy sensors switches
    a. Wattstopper
    b. Leviton
3. Floor Mounted Service Boxes
    a. Hubbell
    b. Walker

2.2 RECEPTACLES

A. Standards:

1. Provide NEMA 5-20R, industrial (heavy-duty) specification or hospital grade as noted herein, 20 amp, 125 VAC, 2 pole, 3 wire grounding type receptacles.
2. Receptacles shall be the standard conventional or designer decora style device.

B. Color:

1. Device color shall be confirmed by architect.

C. General purpose single outlets:

1. Provide self-grounding back and side wired with binding head staked terminal screw.
2. Use Hubbell #2161 series, Pass & Seymour #26361 series or Leviton #16351 series.

D. General purpose duplex receptacles:

1. Provide self-grounding, back and side wired with binding head staked terminal screws and break-off strip for two-circuit wiring.

2. Use Hubbell #2162 series, Pass & Seymour #26362 series or Leviton #16352 series.

E. Ground fault circuit interrupting (GFCI) receptacles:
1. Provide 20 amp, 125 VAC, receptacles consisting of NEMA 5-20R duplex device with integral solid state sensing and signaling circuitry capable of detecting and interrupting a maximum 5 milli-amp line-to-ground fault current in approximately 1/40th of a second.

2. Provide visual device with trip indication, manual reset and test mechanisms and with point of use and multi-outlet protection.

3. Use Pass & Seymour #2091-S series, Hubbell GF-5362 series, Leviton #6898 series, for Specification grade GFCI receptacles.

2.3 WALL SWITCHES

A. Standards: Provide general-purpose 120/277 VAC switches that conform to NEMA WD-1 Specifications.

B. Color: Device color shall be confirmed by the Architect, unless otherwise noted.

C. Wall switches:

1. Provide twenty ampere, 120/277 volt, Specification grade, designer decora style, quick-make slow-break, quiet type snap switch with silver cadmium alloy contacts, binding head terminal screws, back and side wired with totally enclosed case.

2. Single pole, single throw switches: Hubbell #2121 series, Pass & Seymour #26021 series or Leviton #5621-2 series.

3. Double pole, single throw switches: Hubbell #2122 series, Pass & Seymour #26021 series or Leviton #5621-2 series

4. Three way switches: Hubbell #2123 series, Pass & Seymour #26023 series or Leviton #5623-2 series.

5. Four way switches: Hubbell #2124 series, Pass & Seymour #26024 series or Leviton #5624-2 series

2.4 OCCUPANCY SENSOR SWITCHES

A. General:

1. Occupancy sensors shall comply with the latest edition of the California Building Energy Efficiency Standards, California Building Code, Part 6 and be certified by The California Energy Commission. All sensors shall be listed in the most current directory of Certified Occupancy Sensing Devices or be on file with the CEC.

2. Occupancy sensors shall be dual-technology type infrared/ultrasonic as specified herein with voltage and wattage rating equal to the lights being controlled.

3. All sensors shall have an adjustable time delay for turning off lights and a sensitivity adjustment.

4. Ceiling mounted sensors shall operate on low voltage as supplied by control unit. Control unit shall contain power supply and relays for switching loads.

5. Units shall be furnished to cover the areas being controlled. No allowance shall be given for providing sensors improperly sized for the square footage of the controlled area.

B. Color: Device color shall be confirmed by Architect, unless otherwise noted.

C. Wall mounted single level control sensors:

1. Sensor shall be passive infrared type with single level switching capability and coverage up to 900 square feet.

2. Operation shall be manual "ON" and manual or automatic "OFF".

3. Time delay adjustment from 30 seconds to 30 minutes. Set adjustment at 4 minutes.

4. Load capacity of 0 to 1800 watts at connected voltage.

5. For use in small utility closets where dual level switching is not indicated.

6. Wattstopper PW-100, Leviton IPS05-1LZ,

D. Wall mounted dual level control sensors:

1. Sensor shall be dual-technology infrared/ultrasonic type with dual level switching capability and coverage up to 1000 square feet.

2. Operation shall be manual (in two levels) "ON" and manual (in two levels) or automatic (full) "OFF".

3. Time delay adjustment from 30 seconds to 30 minutes. Set adjustment at 10 minutes. Set sensitivity adjustment at maximum.

4. Load capacity of 50 to 1000 watts at connected voltages.

5. Integral photocell, 2 circuit, compatible with electronic bi-level switching ballast. Provide with ambient light control adjustment.

6. For use in offices where dual level switching is indicated.

7. Wattstopper PW-200, Leviton ODS0D-IAW

E. Ceiling mounted single-directional sensors:

1. Sensor shall be dual-technology infrared/ultrasonic type single-directional with coverage up to 900 square feet.

2. Operation shall be automatic "ON" and automatic "OFF". Provide with a manual override switch.

3. Time delay adjustment from 30 seconds to 30 minutes. Set adjustment at 10 minutes. Set sensitivity adjustment at maximum.

4. Load capacity of 20 amps per power or slave pack at connected voltage.

5. Power pack consisting of Class 2, 24V output transformer and relay in single housing, capable of powering up 2 sensors and mounted inside standard 4 inch square box.

6. For use in small office areas.

7. Wattstopper DT-200, Leviton OSC05-RMW

F. Ceiling mounted omnidirectional sensors:

1. Sensor shall be dual-technology infrared/ultrasonic type omnidirectional with coverage up to 1000 square feet.

2. Operation shall be automatic "ON" and automatic "OFF". Provide with a manual override switch.

3. Time delay adjustment from 30 seconds to 15 minutes. Set adjustment at 10 minutes. Set sensitivity adjustment at maximum.

4. Load capacity of 15 amps per power or slave pack at connected voltage.

5. Power pack consisting of Class 2, 24V output transformer and relay in single housing, capable of powering up to 2 sensors and mounted inside standard 4inch square box.

6. Wattstopper DT-300, Leviton OSC10-RMW

2.5 PLATES

A. GENERAL:

1. Provide all cover plates with rounded edges and corners, smooth and free of grooves, embossing or other embellishment.

2. Provide mounting screws to match the plate finish.

3. Provide gang type cover plates where two or more devices are installed at one location. Individual gangable cover plates are not acceptable.

4. Provide plates of one design, designer decora style, throughout the Project unless otherwise specified.

B. Color: Cover plate color shall be confirmed by the Architect, unless otherwise noted.

C. Plastic cover plates:
1. Provide smooth, high impact, thermoplastic cover plates and 0.100 inches thick with rounded edges and corners.

2. Provide openings to accommodate the devices indicated on the Drawings and in the Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumbing and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on bottom. Group adjacent switches under single, multi-gang wall plates.

F. Protect devices and assemblies during painting.

G. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Basic Electrical Materials and Methods."
   1. Switches: Where (3) three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
   2. Receptacles: Identify panel board and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A.

3.4 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Operate each device at least (6) six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 27 26

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:

1. Feeder and branch-circuit protection.
2. Motor and equipment disconnecting means.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. RMS: Root mean square.

C. SPDT: Single pole, double throw.

1.4 QUALITY ASSURANCE

A. 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.

B. Comply with NEMA AB 1 and NEMA KS 1.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Fusible Switches:
      a. Square D Co.
   2. Molded-Case Circuit Breakers:
      a. Square D Co.
   3. Combination Circuit Breaker and Ground-Fault Trip:
      a. Square D Co.
   4. Molded-Case, Current-Limiting Circuit Breakers:
      a. Square D Co.
   5. Integrally Fused, Molded-Case Circuit Breakers:
      a. Square D Co.

2.2 ENCLOSED SWITCHES

A. Enclosed, Non-fusible Switch: NEMA KS 1, Type HD, with lockable handle.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.
   4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
   7. Molded-Case Switch: Molded-case circuit breaker without trip units.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
   1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
   2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
   3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   4. Shunt Trip: 120-V trip coil energized from separate circuit with coil clearing contacts.
   5. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
   6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
   2. Test continuity of each line- and load-side circuit.

B. Testing Agency: Engage a qualified independent testing agency to perform specified testing.

C. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

   1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Infrared Scanning: After Substantial Completion, perform an infrared scan of each enclosed switch and circuit breaker to verify compliance with Section 9 of NETA Acceptance Testing Specifications and Section 18-16 of NFPA 70B. Open or remove doors or panels so connections are accessible to portable scanner.
   1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   2. Record of Infrared Scanning: Prepare a certified report that identifies switches and circuit breakers checked and that describes scanning results. Include

notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 28 16

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install lighting fixtures as shown on drawings and herein specified.

1.2 DEFINITIONS

A. The term Architect refers to the Architect, Interior Designer or Owner'sRepresentative individually or collectively.

1.3 SUMMARY

A. This Section includes interior lighting fixtures, lamps, ballasts, Egress lighting fixtures, and accessories.

B. Related Sections include the following:
   1. Division 26 Section "Lighting Control Equipment" for programmable lighting control systems, time switches, additional photoelectric relays, power relays, and contactors.

1.4 GENERAL REQUIREMENTS

A. Provide all lighting fixtures as shown complete with all lamps, completely wired, controlled and securely attached to supports.

B. Where a catalog number and a narrative or pictorial descriptions are provided, the written description shall take precedence and prevail.

C. General Contractor shall provide electrical subcontractor with entire lighting specification (Including fixture illustrations and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the fixtures they will supply.

D. Type of fixtures shall be as indicated alphanumerically and as specified.

E. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:
   1. Fixture performance is equal or improved;
   2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved; Cost to the Owner is reduced or equal.
   3. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

1.5 QUALITY ASSURANCE

A. Manufacturers: Manufacturers listed in the fixture schedule shall be assumed capable of supplying the listed fixtures unless exceptions are set forth in their quotations. Any such exceptions shall immediately be brought to the attention of the Contractor, the Architect and the Lighting Consultant. Alternate manufacturers may be considered from the proposed list in Paragraph 4 below. Alternate manufacturers must comply with the submittal process and meet all sections of the specification.
   1. Experience: Manufacturer(s) shall have not less than five (5) years experience in design and manufacture of lighting fixtures of the type and quality shown. Pre- qualification submissions must include a list of completed projects and dated catalog pages or drawings indicating length of experience.
   2. Alternate Manufacturers: Alternate manufacturers listed in the fixture schedule may be considered provided all of the following conditions are met or exceeds the specified manufacturer:
      a. Demonstrates fixture performance is equal or improved
      b. Meets aesthetic considerations as established by the Architect / Owner.
      c. The cost to Owner is reduced
      d. Improves delivery schedule
   3. Manufacturers wishing to be considered, other than listed above, shall submit in writing for approval by the Owner and Architect.

B. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

C. Comply with NFPA 70.

D. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

E. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.6 STANDARDS

A. The standards and regulating committees referred in this specification and to which compliance with is required are:
   1. UL Underwriters Laboratories
   2. NRTL Nationally Recognized Testing Laboratory
   3. NEC National Electric Code
   4. ANSI American National Standards Institute
   5. ASTM American Society of Testing and Materials
   6. NEMA National Electrical Manufacturers Association
   7. IEC International Electrotechnical Commission

B. All fixtures and assembled components shall be new, of good quality, and be approved by and bear the label of UL for the applicable location and conditions (wet,

damp, dry, etc.) or other approved testing agencies, i.e. CSA, ETL, unless otherwise specified in writing.

C. All fixtures shall meet all required local, state and/or national building, electrical and energy codes and regulations.

1.7 SUBSTITUTIONS

A. Bidders' attention is called to the following procedure to be followed in submitting alternate fixture manufacturers than those specified:

1. If the bidder wishes to substitute fixtures from alternate manufacturers, his attention is called to Section 2.01, GENERAL MATERIAL REQUIREMENTS of PART 2 - PRODUCTS. In addition, he shall note that the dimensions of visible parts of many fixtures (for example, the aperture diameters of incandescent fixtures) are binding to the bidder and cannot be changed without prior approval by the Architect.
2. Contractor shall pay professional fees (at current standard hourly rates) and reimburse expenses directly to all designers (Architect, Engineer, Lighting Designer, et. al.) for time spent reviewing substitutions proposed by the Contractor. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
3. Request for approval shall be accompanied by working fixture samples (with an appropriate lamp, complete photometric, mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Architect. The fixture samples shall be furnished and installed, at the bidder's expense, at the location selected by the Architect. In addition, the bidder shall furnish the Architect with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six(6) months, as well as the names and addresses of the Owner, the Lighting Designer and the Architect of record.

1.8 SUBMITTALS

A. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including lamping; ballast manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification.) If cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.

B. For standard cataloged fixtures:

1. Submit one sample cone for each fixture type for review. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.

2. When more than one louver panel occurs in a fixture, submit as a part of shop drawings the dimensioned layout of individual louver panels and supporting "tee" members.

C. For custom fixtures, modified fixtures or linear fluorescent fixtures mounted in continuous rows, submit a sepia drawing prepared by the manufacturer showing all details of construction, lengths of runs, lamping layout, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required. If scallop shields, wallwash reflectors or baffles are required, drawings shall indicate relative position to wall or adjacent vertical surface.

D. For all submittals under paragraphs A through C above, manufacturer shall provide submittals with fixture installation instruction sheets.

E. For all submittals under paragraphs A through C above, manufacturer shall provide submittals within two weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.

F. Fixture cuts and shop drawings shall be submitted in quantities and format as described in the general conditions section the specification.

G. The Architect shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request a shop drawing if the fixture cut is insufficient.

H. MOCK-UPS
1. It shall be the responsibility of the Contractor to provide a mock-up of the lighting fixture or lighting systems as indicated in the fixture description. The mock-up shall be erected within a time period and in a location that is acceptable to the Architect.
2. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from ceiling, number and type of lamps, material, color and etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Architect's approval prior to commencement of each mock-up.
3. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color and etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.

I. SAMPLES
1. It shall be the responsibility of the Contractor to provide a sample(s) fixture as indicated in Section 2.02, LIGHTING FIXTURE DESCRIPTIONS. When samples are called for the manufacturer shall provide two working samples complete with lamp, ballast (rated for 120 Volt operation) and 6’ pig-tail with 3-prong Edison plug.

2. The sample(s) shall be shipped to a location that is determined by the Architect.Shipping and return shipping costs shall be provided as part of the contract.
3. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.
4. Sample fixtures may not be used on the project.

1.9 EXTRA STOCK

A. Furnish to the owner and store at the site where directed, extra stock of each type of lighting fixture type and lamp type installed in the Project in quantities as required by Owner, packaged in manufacturer's unopened cartoons and identified as to contents by fixture type.

B. Furnish items above with appropriate quantity of each exposed trim, fastener, bracket and other items as required for a complete installation.

1.10 WARRANTIES

A. All fixtures and workmanship shall be guaranteed free of defects and fully operational for a minimum of one year after the acceptance of the project by the Owner. Any fixtures or workmanship found to be defective during the warranty period will be either fixed or replaced by the Contractor at no cost to the owner

B. Ballasts for fluorescent fixtures shall be covered by a five year warranty and high intensity discharge fixtures shall be covered by a two year warranty against defects in workmanship or material. Warranty shall include in-warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative, in- warranty ballasts.

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

A. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked paint process to prevent corrosion and discoloration of adjacent materials.

B. For weatherproof and vaportight installation, painted finishes of fixtures and accessories shall be weatherproof enamel using proper primers or hot dipped galvanized and bonderized epoxy, in accordance with manufacturer's requirements. Unless otherwise specified all painted surfaces shall have a life expectancy of not less than twenty years.

1. Hangers shall be conduit with chemically resistant, weatherproof, baked enamel finish.
2. Where dissimilar metal parts come in contact with each other, apply to both surfaces a coating material to prevent corrosion.
3. Colors shall be as specified in the LIGHTING FIXTURE DESCRIPTION section of this specification.

C. Fasteners shall be manufactured of non-magnetic stainless steel or anodized aluminum, except in indoor applications where galvanized steel shall be acceptable.

D. Fixtures shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps and ballasts including vent holes where required.

E. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. All sheet metal shall be free of light leaks. All edges shall be finished so there are no sharp edges exposed. All miters shall be in accurate alignment with abutting intersecting members. Piecing of plates in individual runs in single planes and the use of spliced pieces or filler material to cover defective workmanship shall not be acceptable. Sheet metal work shall be properly fabricated so that planes will not deform (i.e. become concave or convex, due to normal expected ambient and operating conditions).

F. Lampholders shall hold lamps securely against normal vibrations and maintenance handling. Provide solid nickel or nickel-and-silver-plated contacts in lampholders for following types oflamps:
1. Mogul screw base incandescent, metal halide, mercury vapor lamps and high pessure sodium.
2. Lamps in outdoor fixtures.
3. Tungsten-halogen lamps.

G. Wiring channels and lampholder mountings shall be rigid and accurately made.

H. Reflector Cones:
1. Provide 45° lamp and lamp image cut-off unless otherwise specified. In fixtures where upper reflector is separate from cone, cut-off shall be 45° unless otherwise specified.
2. Plastic materials shall not be used for reflector cones or aperture plates.
3. Fixtures in which reflector cones are riveted or welded to housing or where removal of cone requires pressure to be applied to finished surface of reflector shall not be acceptable.
4. Cone flange shall be formed as an integral part of the cone and shall have identical color and finish as the cone, except as shown. The flange major surface shall be perpendicular to the cone axis. The width of the flange shall adequately cover the ceiling opening without light leaks. No fixture parts (housing, mounting frame, etc.) shall be visible between the ceiling surface and the edge of the cone flange. The same requirement shall be applicable to fixtures where main reflector extends down to the bottom edge of the fixture without a separate cone.

In such case, the flange shall be formed as an integral part of the main reflector.

5. Reflector cones shall be manufactured of uniform gauge, not less than 0.032" thick, high purity aluminum Alcoa 3002 alloy free of spin marks or other defects or blemishes caused during manufacturing.
6. The finish of the inner surface of the reflector shall be highly specular as produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 83% on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles. Colors shall be derived from dyes supplied by Sandoz Chemical Company or approved equal.
7. The reflecting surface of the cone shall be tested for proper sealing. Test per ASTMB136-63T.
8. Fixtures with Alzak reflector cones, unless otherwise specified, must be furnished by the same manufacturer.
9. Reflector cone retention devices shall not deform cone in any manner whatsoever.
10. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.

I. Lenses:

1. Fresnel:
   a. Lens shall have uniform brightness throughout the entire visible area at angles from 45° to 90° from vertical, without bright spots or striations.
   b. Lens shall have opaque risers; color shall be as specified in Section 2.02, LIGHTING FIXTURE DESCRIPTIONS.
   c. Finish of visible regress surface of door shall be matte baked enamel paint, special color as selected by Architect.
   d. All fixtures with fresnel lenses, unless otherwise specified, must befurnished by the same manufacturer.
2. Glass:
   a. Flat glass lenses shall be heat tempered borosilicate glass unless otherwise noted.
   b. Glass finishes, i.e. sandblasting, etching, polishing shall be performed as described in the fixture description.

3. Acrylic:
   a. Lenses shall be of injection molded crystal clear material 100% virgin acrylic (except as shown). For lenses with male pattern of pyramids or cones, specified minimum thickness refers to distance from flat surface to base of pyramids (cones), or thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material.
   b. Lenses shall fully eliminate lamp images when viewed from all directions within the 45° to 90° angle from vertical when the ratio of lamp spacing to the distance from lamp underside to top of lens does not exceed 1.50. Within the viewing angle from 0° to 45° the ratio of maximum brightness

(under a lamp) to minimum brightness (between lamps) shall not exceed 3 to 1.

c. Finishes, i.e. sandblasting, etching, polishing shall be performed as described in the fixture description.

J. Louvers:
1. Parabolic:
a. Louvers shall be continuously bound in channel formed frame, finish and color as specified or as selected.
b. Louver shall provide a minimum visual cut-off to the lamp of 45°.
c. The finish of the inner surface of the reflector shall be highly specular as produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 83% on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles.
2. Flat Blade:
a. Provide flat blade louvers within formed frame, finish and color as specified.
b. Louvers to provide minimum of 45° degree cut-off from lamp image.
c. Blade thickness to minimum .125” flat steel.

K. In adjustable fixtures, aiming and positive locking devices shall be provided.

L. Fixtures with an adjustable lamp and using a lamp with an asymmetrical light pattern shall have an aiming stop which can be permanently set so that the lamp shall remain correctly positioned after service or relamping.

M. Fluorescent Fixtures:
1. Hot Cathode:
a. Housing:
1) No. 22 minimum gauge steel, bonderized or equal rust protected, or No. 16 gauge aluminum rigid construction, suitable for continuous row mounting where indicated.
2) Finish: Baked enamel paint finish unless otherwise specified, color as specified or as selected.
b. Reflector: Minimum 85% reflectance.
c. Lightshields:
1) Frames: Provide extruded aluminum frames with mitered corners filled and ground smooth. Provided with concealed hinges and invisible latching.
2) No cross bars shall be permitted over lightshields.
d. Lampholders:
1) Lampholders shall be UL listed, and meet IEC-60400, “International Standard: Lampholders for tubular fluorescent lamps and startholders”.
e. For rapid start lamps on single ballasts, provide one (1) grounding lampholder per lamp. Lampholders operating with open circuit voltage in

excess of 300 volts shall be safety type and shall open supply circuit when lamp is removed from lampholder.

1) Mount lamps used in rapid start circuits 430mA and below: within 1/2" of grounded metal as long as the lamp.
2) 800mA and 1500mA lamps: mount within 1" of grounded metal as long as the lamp.

f. Fluorescent fixtures shall conform to NEMA Standards, including references to fixture dimensions and temperature ratings.

g. Ballasts shall be electronic high power factor (greater than 90%), ballast factor (greater than 87%) and approved by UL (UL 935 listed). Ballasts shall be certified for voltage and number of lamps specified and equipped with internal thermal protectors unless otherwise specified.

1) Ballasts shall have a Crest Factor of less the one and seven tenths.
2) Ballasts for indoor applications shall be "Class P".
3) Provide multi-lamp ballasts where possible including continuous rows of one-lamp fixtures, and one-lamp ballasts only where the fixture layout does not permit the use of multi-lamp ballasts.
4) Ballast shall be a dedicated ballast to operate a specific lamp, i.e., T8 ballasts specifically for a T8 lamp.
5) All ballasts shall operate at the voltage as described in Section 2.02, LIGHTING FIXTURE DESCRIPTIONS and confirmed on electrical drawings. Ballasts shall operate lamps properly through the following supply voltage ranges:
   a) Rated voltage +/- 10%
   b) Universal voltage of 108 to 305V on 50 or 60Hz supply
6) Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.
7) Frequency shall be 20 Khz or greater except as noted without and discernible flicker (<3% flicker index).
8) Ballast shall have input current total harmonic distortion not to exceed 10% of the fundamental harmonic (60 Hz).
9) Ballast shall not contain PCB materials.
10) Ballast shall provide transient immunity as recommended by ANSI C62.41-1991 location Category A2.
11) Ballast shall be encapsulated to ensure maximum thermal and structural integrity.
12) Ballast minimum sound ratings:
   a) 265 mA: Class 'A'
   b) 430 mA: Class 'A'
   c) 800 mA: Class 'B'
   d) 1500 mA: Class 'C'
13) All fixtures installed in exterior or unheated interior spaces shall be supplied with ballasts which start lamps down to 0°F unless noted otherwise.
14) Ballasts for T5, T5HO, and CFL lamps shall incorporate auto resetting lamp shutdown circuitry for end of lamp life protection thereby allowing for relamping without the need to cycle power.
15) Program Rapid start ballasts shall be used when the lamps are to be frequently turned on/off (with cycles of less than 3 hours).

Otherwise ballast shall provide instant starting sequence consistent with ANSI standard C82.11-1993.

16) Ballast shall be manufactured in an ISO 9002 certified facility.
17) Manufacturer shall have minimum 15 years of manufacturing experience.
18) Ballast, unless specified otherwise, shall be same manufacturer and model in each fixture of the same type. Acceptable ballast manufacturers unless otherwise noted are:
    a) Advance
    b) Universal Lighting Technologies
    c) Osram/Sylvania
    d) Lutron
    e) Lighting fixtures recessed in a hung ceiling where the space above the hung ceiling is used as a plenum chamber for either supply or return air for the air conditioning system shall be designed, manufactured and wired to conform to NEC Article 300-22.

2. When specified, fluorescent luminaires shall have radio frequency interference (RFI) or electromagnetic interference filters. Filters shall either be integral external to the ballast, but must be integral to the luminaire assembly with one filter per ballast and shall suppress electromagnetic interference in the AM radio band from 500 to 1700 kHz. Filters shall also be in the circuit serving the lighting fixture.

N. Incandescent Fixtures:

1. Incandescent fixtures, unless otherwise specified, shall be operated at 90% of rated lamp voltage by means of a bucking transformer at the distribution panel for extended lamp life. Bucking transformers shall not be used on those circuits where dimmers are used Refer to Electrical Engineers drawings and Specifications for manufacturer, quantity and size of bucking transformers required. (Refer to LIGHTING FIXTURE SCHEDULE, for lamp voltages.)
2. Housing:
   a. Steel, bonderized or equal rust protected or aluminum, rigid construction. Minimum gauge thickness shall be as follows:

      1) Interior locations: No. 20 gauge steel, No. 16 gauge aluminum.
      2) Exterior locations: No. 18 gauge steel, No. 14 gauge aluminum.

   b. Finish: Baked enamel finish (except when otherwise specified).

      1) Concealed interior surfaces (this applies to interior hardware, lampholders, yokes, brackets, etc.): matte black.
      2) Concealed exterior surfaces: matte black.
      3) Visible surfaces: color and texture as specified below for each fixture type or as selected.

3. Reflector Cones: refer to "Reflector Cones", above.

4. Reflectors not visible within normal viewing angles shall be highly specular as produced under the Alzak process, except when otherwise specified. Minimum reflectance shall be 83%.

5. Provide safety devices for removable fixture elements (cones, reflectors, lenses and fixture doors, etc.). Safety devices shall support removable elements when not in normal operating position, and be detachable if necessary. This device shall not interfere with fixture performance, maintenance, or the seating of any fixture element, and shall not be visible during normal fixture operation.

6. Thermal protection device shall be provided as required by code.

O. High Intensity Discharge Fixtures:

1. Housing, where applicable:

a. Steel bonderized or equal rust protected, or aluminum, rigid construction. Minimum gauge thickness shall be as follows:

1) Interior locations: No. 20 gauge steel, No. 16 gauge aluminum.
2) Exterior locations: No. 18 gauge steel, No. 14 gauge aluminum.

b. Finish: Baked enamel finish.

1) Concealed surfaces: matte black.
2) Visible surfaces: color and texture as specified below for each fixture type or as specified in Section 2.02, LIGHTING FIXTURE DESCRIPTIONS.

c. Lampholder housing: cast aluminum with integral heat radiating fins to assure cool lamp base operation.

d. Fixture housing design shall provide for top and bottom relamping, unless otherwise specified.

2. Reflector: High purity (not less than 99.0%) aluminum. Specular finish shall be achieved by mechanical- and electro-polishing. Reflector shall be anodized to prevent surface corrosion or deterioration. The reflectance shall not be less than 83%.

3. Provide safety devices for removable fixture elements (cones, reflectors, lenses, fixture doors, etc.). Safety devices shall support removable elements when not in normal operating position, and be detachable if necessary. This device shall not interfere with fixture performance, maintenance, or the seating of any fixture element, and shall not be visible during normal fixture operation.

4. Magnetic Ballasts: High power factor, UL approved constant wattage auto-transformer type for voltage and lamp specified - 60 hertz.

a. Ballasts shall be designed in accordance with all applicable ANSI specifications including ANSI C82.4 and shall comply with UL 1029.

b. Ballasts shall have a normal ambient operating temperature of 104 degrees F.

c. The light output shall not vary more than 11% with a +/- 5% voltage variation in high reactance circuit

d. The light output shall not vary more than 5% with +/- 10% voltage variation in CWA circuit.

e. Lamp drop out voltage shall not exceed minus 25% of the rated voltage for the high reactance circuit and minus 30% for the CWA circuit.

f. Ballasts for indoor applications shall be encased in a housing which provides necessary wiring compartments and provisions for required electrical connectors or devices.

g. Ballast components shall be surrounded with a thermosetting fill to assure adequate heat dissipation and quiet operation.

h. Ballasts shall be provided with necessary mounting hardware and vibration dampers.

5. Electronic Metal Halide ballasts:

a. Unless specified otherwise, shall be same manufacturer and model in each fixture of the same type.

b. Shall have an input voltage range with a variation of at least +/- 20% and +/- 1% lamp regulation resulting in greater lamp stability in areas with poor power regulation.

c. Output shall be “square wave” with an operating frequency of less than 200 Hz.

d. Shall incorporate a “Turn Off” shutdown safety feature not exceeding a response time of 3 seconds to prevent excessive ignition, undue system stress and improved long term performance of the ballast under the following conditions: no lamp, failed lamp, end of life lamp, leaker lamps and other sustained abnormal conditions such as rectification and glow mode.

e. Shall comply with FCC Part 18 Class A. The manufacturer shall provide documentation of compliance with non-consumer limits for EMI & RFI.

f. Shall have a Total Harmonic Distortion (THD) less than 10%.

g. Shall have a lamp Crest Factor of les than 1.3.

h. Shall have a Power Factor of not less than 96%.

i. Shall be sound rated “A”.

j. Shall be equipped with internal thermal protection to shut down the ballast when operating temperatures reach unacceptable levels.

k. Shall be UL and CUL “Listed or Recognized” for 120v and 277v applications and CE “Listed” for 220 to 240v 50 Hz applications.

l. Shall incorporate a metal case and be suitable for recessed use.

m. Shall be designated Type 1 – Outdoor

n. Shall be capable of remote mounting with a distance of not less than 10’-0”.

o. Shall incorporate Electrolytic Capacitor(s) with minimum rating of 8,000 hours at 105 degrees C and a minimum life expectancy exceeding 64,000 hours at 75 degrees C.

p. Manufacturer shall offer a Five (5) year product warranty.

q. Manufacturer shall have a minimum of fifteen (15) experience in the manufacture of electronic power lighting products, two (2) years experience in the manufacture of Electronic Metal Halide ballasts and no less than fifty thousand (50,000) units installed worldwide.

r. The specified lamps shall be approved and/or warranted by the lamp manufacturer for use with the designated Electronic Metal Halide ballast.

s. Shall have built in circuit protection.

t. Shall have a designated ballast factor of 1.0.

u. Acceptable ballast manufacturers unless otherwise noted are:

1) Aromat
2) Hatch
3) Metro-light

6. Lighting fixtures recessed in a hung ceiling where the space above the ceiling is used as a plenum chamber for either supply or return air for the air conditioning system shall be designed, manufactured, and wired to conform with NEC Article 300-22.

7. Provide clear glass safety lens in all Metal Halide fixtures unless otherwise noted.

P. Wiring:

1. Voltage Rating

a. For voltages up to 120 volts fixture wiring shall be rated for 300 volts minimum.

b. For voltages above 120 volts fixture wiring shall be rated for 600 volts minimum.

2. Temperature Rating - Internal to Fixture

a. All wiring shall be code-approved for fixture wiring, and shall comply with the following temperature ratings unless fixture design or local codes require higher temperature wire.

b. Incandescent

1) minimum rated between lampholder(s) and separately mounted junction box or internal transformer.

2) minimum rated between internal transformer and separately mounted junction box.

3) Tungsten-halogen lamp seal temperature shall not exceed 350°C at ambient of 25°C when tested per UL Bulletin 57, Par. 328-334. Submit certified heat test data by independent testing laboratory.

c. Fluorescent

1) minimum rating between lampholder(s) and internal ballast.

2) minimum between ballast and separate junction box, or connection within integral wireway.

d. High Intensity Discharge

1) minimum rating between lampholder(s) and separate junction box or connections with ballast components.
2) minimum rating between core and coil ballast components and separate junction box.
3) minimum rating between encased and potted ballast components and separate junction box.

3. Temperature Rating - External to Fixture
a. All flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105°C.
b. Cord type shall be suitable for application and shall be fitted with proper strain relief and watertight entries where required by application.

4. Splices
a. Splices internal to fixture shall be made within separate splice compartments and shall utilize nylon insulated crimped connections or insulated quick disconnects.
b. Splices to branch circuit wiring in separate junction boxes shall utilize flame retardant thermoplastic caps with fully seated helical metal spring and threaded entry.

5. No internal wiring shall be visible at normal viewing angles, i.e., above 45° from vertical. Use additional wire clamps if necessary. Anticipate increased visibility if fixtures are mounted on or recessed within a sloping surface.

6. Any fixture fed from more than one panel, i.e., for normal and night or emergency operation, shall have separate neutrals to each panel.

7. Furnish code-approved wiring in ceiling cavities forming air plenums.

Q. Lamps:

1. Hot cathode fluorescent lamps: shall be 3000° Kelvin, with 85 CRI or greater except as shown. Refer to Section 2.02, LIGHTING FIXTURE DESCRIPTIONS for details. All lamps, except as specified, shall be of the same manufacturer:

a. General Electric
b. North American Philips
c. Osram/Sylvania

2. Cold cathode lamps: Lamps shall produce 300 lumens per foot (warm white) when operating at 120 mA, 440 lumens per foot (warm white) when operating at 200 mA, and shall not depreciate more than 20% after 10,000 hours of normal operation. Lamps shall be made from 1" diameter lead glass halo-phosphor coated and baked, with heavy-duty coated electrodes, and shall be fabricated to the shapes and sizes as shown on drawings. Lamps shall be processed with a high-speed mechanical pump at least 100 liters free air capacity, backed up by a three-stage oil diffusion pump able to produce a vacuum of 10-7 and accurate gauges

and meters for measuring and controlling pressures, temperatures, carrier gas and mercury. Completed lamps shall be silicon coated and aged for 15 hours. Lamps showing end darkening, stains, discolorations,spiraling or sputtering shall be rejected.

3. Incandescent lamps:
   a. 120 volt, except as shown. Refer to Section 2.02, LIGHTING FIXTURE DESCRIPTIONS for details.
   b. All lamps, except as specified, shall be of the same manufacturer:

      1) General Electric
      2) North American Philips
      3) Osram/Sylvania

   c. Energy saving type lamps which use an electronic diode shall not be used unless otherwise specified in Section 2.02, LIGHTING FIXTURE DESCRIPTIONS.

4. High intensity discharge lamps: Refer to Section 2.02, LIGHTING FIXTURE DESCRIPTIONS for details. All lamps, except as specified, shall be of the same manufacturer:

   a. General Electric
   b. North American Philips
   c. Osram/Sylvania
   d. Venture

O. Air Handling Troffer Fixtures:
   1. Refer to mechanical drawings and specifications for requirements, if any.
   2. Air diffusers shall be supplied by others.

2.2 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:
   1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs: As follows:
   1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

2.3 EMERGENCY LIGHTING

A. General Requirements: Unless otherwise indicated on the plans all light fixtures designated to provide emergency egress lighting shall be connected to the base building legally required emergency system.

B. Self-contained units. Comply with UL 924. Units include the following features:

1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when 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, and battery is automatically recharged and floated on charger.

2.4 LIGHTING FIXTURES DESCRIPTIONS

A. Refer to attached light fixture schedule at the end of this section.

PART 3 - EXECUTION

3.1 SHIPPING AND STORAGE

A. All fixtures received at the site shall be stored in clean and dry space until fixtures are installed.

B. Manufacturer shall clearly mark each box with fixture designation prior to shipping.

C. Reflector cones, baffles, louvers, aperture plates, and decorative elements of fixtures shall be packed by the manufacturer separate from the housing (body, stem, etc.) of the fixture.

3.2 LOCATION

A. Locations of fixtures are shown diagrammatically. Verify exact location and spacing with Reflected Ceiling Plans and other reference data before ordering of fixtures and during installation.

B. Notify Architect about field conditions at variance with Contract Documents before commencing installation.

C. Coordinate space conditions with other trades before ordering of fixtures.

D. Pendant mount, as approved, surface type fixtures where required to meet space conditions.

E. Coordinate length of continuous-run fluorescent fixtures with adjacent walls, partitions, coffers and other architectural elements as required.

1. Continuous runs shall be defined as the optimal combination of 3’ and 4’ lamp length as necessary to complete runs with no more than 6” of free space at either end of the run as provided by the contractor.

3.3 INSTALLATION

A. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Fixture catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a fixture may be installed.

B. Provide adequate and sturdy support for each lighting fixture. Contractor shall be responsible for verifying weight and mounting method of all fixtures and furnish and install suitable supports. Fixture mounting assemblies shall comply with all local seismic codes and regulations.

C. Install rows of fixtures accurately on straight lines unless otherwise indicated on drawings. Coordinate with mechanical work.

D. Install fixtures with vent holes free of air blocking obstacles.

E. Where plaster ceilings occur, furnish plaster frames for setting under other applicable sections. Direct the setting and be responsible for correct location; make sure the bottom of frame is flush with finished ceiling, forming screed edge for finished plaster.
   1. Fixtures shall be supported by plaster frames utilizing yokes or leveling lugs.
      a. Fixtures and support elements shall not be mounted to or in contact with ducts or pipes.
      b. Yoke shall have channel cross section of sufficient gauge, and shall support a fixture by means of not fewer than two (2) bolts each.

   2. If air diffusers are located in common continuous rows with lighting fixtures in plaster ceilings, furnish plaster frames of proper length to accommodate diffusers.
   3. Lighting fixtures recessed in ceilings which have a fire resistive rating of one hour or more shall be enclosed in a box which has a fire resistive rating equal to that of the ceiling.

F. Contractor shall be responsible for adjusting aperture rings on all ceiling recessed fixtures to accommodate various ceiling material thickness. Contractor shall responsible for coordinating the cut-out size in ceiling to ensure aperture covers cut-out entirely. The bottom of aperture rings shall be flush with finished ceiling or not more that 1/16" above. Under no circumstances will the aperture ring extend below the finished ceiling surface.

G. For fixtures with variable position lampholder assemblies Contractor shall confirm prior to installation proper lampholder (socket) position in field, and shall adjust, if necessary, after coordination with manufacturer.

H. Surface Mounted Fixtures: Support surface mounted fixtures from structural members other than ceiling tees.

I. Pendant Mounted Fixtures:
   1. Pendant mounted fixtures shall be supported from structural framework of ceiling or from inserts cast into slab.

2. All pendants shall have swivel aligners located at the top ends; pendants shall be 1/2" rigid steel conduit unless specifically indicated otherwise on drawings or in specifications.
3. All fluorescent pendant and surface mounted fixtures shall be supported with two (2) supports per four foot section or three (3) per eight foot section.

J. Bracket Mounted Fixtures: For each bracket fixture, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the fixture rigidly in design position. Flanged part of fixture stud shall be of broad base type, secured to outlet box at not fewer than three (3) points.

K. Top Relamping Fixtures: Top relamping fixtures shall have the necessary top-relamping screws loosened and moderately tightened, prior to installation, to assure ease of operation when relamping is required.

L. Fluorescent Fixtures: Replace noisy ballasts as directed, at no cost to the Owner.

M. High Intensity Discharge Fixtures: Replace noisy ballasts as directed, at no cost to the Owner.

N. Mask the trims and bottoms of all lighting fixtures if necessary to protect the fixture during construction.

O. At the completion of construction clean the bottoms, the trim, the reflecting surfaces, lenses, baffles, louvers and reflector cones of all lighting fixtures so as to render them free of any material, substance or film foreign to the fixture. If the luminaires are deemed dirty by the Architect at the completion of the project, the Contractor shall clean them at no additional cost to the Owner. Luminaire components whose finishes are damaged shall be replaced at no cost to the Owner.

P. Ascertain and ensure that all lamps installed are exactly as specified for each fixture type. If any deviation is noticed in the field, Contractor shall replace all lamps as specified at no additional cost to Owner.

Q. Replace all burned-out or inoperative lamps, and inoperative ballasts in all high intensitydischarge and fluorescent fixtures before the building is accepted by the Owner so that all lighting fixtures will be in first-class operating condition.

R. Re-lamp all specified H.I.D. fixtures used as construction work lights with new specified lamps. No H.I.D. lamps shall have a burning hours difference which exceeds forty (40) hours.

S. Re-lamp all specified incandescent fixtures used as construction work lights with new specified lamps. No incandescent lamps shall have a burning hours difference which exceeds forty (40) hours.

T. Provide labor and materials for final aiming of all adjustable fixtures under the Architect's supervision. Aiming shall take place immediately before building is turned over to Owner, afterregular working hours where required.

U. Testing: As follows:
1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
3. Verify normal transfer to battery source and retransfer to normal.
4. Report results in writing.

END OF SECTION