

DIVISION 26**ELECTRICAL**

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SECTION 26 00 00
ELECTRICAL BASIC REQUIREMENTS

PART 1 - GENERAL**1.01 DESIGN-BUILD SUMMARY OF WORK**

- A. Work included in 26 00 00 applies to Division 26, Electrical work to provide materials, labor, tools, permits and incidentals to make electrical systems ready for Owner's use for proposed project

1.02 DESIGN-BUILD INSTRUCTIONS

- A. This document is issued to give Bidders a basis for preparing a proposal to design and install a complete electrical power, lighting and signal system for this project.
- B. Alternates to this Document may be offered as a separate proposal.
- C. Bidder to submit the following information with the Proposal:
 - 1. Preliminary schematic drawing indicating power distribution system (one-line diagram) to include proposed system capacity and expansion capacity, expected available fault current at the service equipment, fault duty ratings of proposed equipment, load survey and maximum voltage drop at distribution equipment.
 - 2. Description of lighting system, indicating luminaire types and manufacturer and method of control.
 - 3. List of wiring materials proposed for systems which are applicable to this project, e.g., switchgear, panels, motor control centers, transformers, generators and transfer switches, life safety and signal system equipment, and the like.
 - 4. Any other information which the bidder considers pertinent in evaluating the proposal.

1.03 DESIGN-BUILD DESIGN APPROACH

- A. Use this Specification as a guide for design/engineering requirements, workmanship and materials or construction. Utilize design-build concept throughout construction phase of project.
- B. Investigate and be apprised of applicable codes, rules, and regulations as enforced by Authority Having Jurisdiction (AHJ).
- C. Visit the Site of the proposed construction. Verify and inspect the existing site to determine conditions that affect this work.

1.04 DESIGN-BUILD DESIGN CRITERIA/CALCULATIONS

- A. Design Criteria:
 - 1. Base Service: 208-volt, 3-phase, 4-wire
 - 2. Coordinate with serving utility for total building load, including added HVAC. Replace existing utility transformer and upgrade secondary conduits to existing switchboard as required for added load.
 - 3. Service Loads: Calculate added loads to existing electrical service, using as-built electrical drawings supplied by building owner, to show new panelboards are properly sized and existing switchboard does not require replacement. Utilize code acceptable diversity factors as allowed by code.
 - 4. Demolition: Existing electrical panels, equipment, lighting and power outlets to remain as is unless otherwise noted below. Maintain function of existing paging and clock systems of building through construction. Fire alarm system and phone/data cabling will be replaced under a separate Contract; do not remove these systems without prior authorization from Owner.
 - 5. HVAC and Plumbing:
 - a. Coordinate with Divisions 22 and 23 so that existing system (air handling units, boilers, heating water pumps, finned tube radiators, water heaters, circulation and booster pumps) are operational again.
 - b. Add additional panelboards as needed to existing main switchboard (1200-amp, 208Y/120-volt panel, 3-phase, 4-wire fused switchboard installed in 1990) as needed

- to supply power to added HVAC and plumbing equipment as detailed in Divisions 22 and 23 design/build specifications.
- c. At this writing, mini split systems are anticipated for classrooms (2.5 ton outdoor units for each classroom), office/admin area (two 5 ton for open office area and one 1-ton for each enclosed office), commons space (two 5 tons units); each of these units will be either 208-volt, 3-phase or 208-volt, 1-phase. In addition, there will be indoor fan coil units (120-volt fractional horsepower) and integral condensate pumps (120-volt fractional horsepower) associated with each outdoor unit.
 - d. Each new classroom restroom will receive one exhaust fan (120-volt, fractional horsepower).
 - e. In gym, provide two 14-foot diameter ceiling fans to enhance comfort with increased airflow. Adjust location of existing lighting to avoid strobing effect from fan blades spinning under overhead lighting, as directed by Owner and Architect. Fan: Big Ass Fans Model Basic 6. Fan controller: Big Ass Fans Smart-Sense Wall controller or approved.
6. Electrical Distribution:
- a. Provide added panelboards dedicated to serving new HVAC equipment.
 - b. Connect added convenience outlets to existing panelboards. Connect new lighting to existing lighting branch circuits.
 - c. In tenant spaces over 200 amp provide feeders in 4 inch EMT.
7. Lighting:
- a. Existing lighting (indoor and outdoor) to remain except as noted below. Where existing lighting is to remain, clean luminaires and relamp. Replace failed ballasts one-for-one.
 - b. Reception Kiosk: provide recessed LED downlights for new soffit area. Minimum 40fc level at desk level. Downlight 4-inch diameter, 3-inch deep housing, white flange with diffusing lens. Focal Point ID 3+ 3.5, Zumtobel, Lightolier series or approved; matching existing color temperature of surrounding lighting.
 - c. New Bathrooms: provide recessed LED downlights in hard lid ceiling to replace existing lighting for minimum 30 fc level at sink counters and over toilets and urinals. Downlight 4-inch diameter, 3-inch deep housing, white flange with diffusing lens. Focal Point ID 3+ 3.5, Zumtobel, Lightolier series or approved. Provide dual tech ceiling occupancy sensor for hands-free automatic control of lighting.
 - d. Entry at NE end of building: provide recessed LED downlights in hard lid ceiling to replace existing lighting for minimum 25 fc level at floor level. Provide integral batteries with test switches for one footcandle illumination in this area for life safety code. Downlight 4-inch diameter, 3-inch deep housing, white flange with diffusing lens. Focal Point ID 3+ 3.5, Zumtobel, Lightolier series or approved.
 - e. Emergency lighting scope of work: test existing exit signs and wall battery packs. If either does not provide 90 minutes emergency illumination to meet current code, replace one-for-one. Add additional battery packs as needed for one footcandle along emergency egress paths.
 - f. Exit signs: Thermoplastic white finish, LED source, NiCAD battery, self-diagnostics, letter color to match building standard, Lithonia LQM, Cooper, Evenlight or approved.
 - g. Emergency wall packs: Thermoplastic white finish, two 1.5W LED adjustable heads, NiCAD battery, self-diagnostics, Lithonia ELM2, Cooper, Evenlight or approved.
8. Receptacles: convenience outlet located within 25-feet of added HVAC equipment as required by code. Connect to nearest convenience outlet circuit not otherwise serving electronic equipment (flat screen monitors, PCs, etc.). 20 amp/1 phase duplex receptacle per 20 linear feet of perimeter walls and/or as shown on Drawings. Provide branch circuiting complete. Provide weatherproof receptacles and connections as shown on Drawings.
- a. Replace existing outlets throughout building one-for-one with tamperproof receptacles as required by OESC for rooms with young children.
 - b. Replace existing outlets where required by OESC with GFCI receptacles.

- c. Test existing receptacles and replace with standard duplex receptacle where GFCI or tamperproof receptacle is not otherwise required.
 - d. HVAC: Provide complete electrical connections to HVAC units as designed and installed by Contractor. Provide duplex receptacles on roof to have a duplex receptacle within 25 feet of each unit.
9. Lighting controls:
- a. Clean and/or replace rooftop photosensor and electronic time clock for control of outdoor lighting.
10. Site Work:
- a. Power and signal connections to new generator. Provide six each site lighting bollards per site plan.
- B. Calculations:
1. Submit calculations for lighting energy consumption using the State of Oregon energy forms.
 2. Submit service and feeder load data.
 3. Submit fault duty calculations for entire electrical distribution system.
 4. Submit voltage drop calculations from main service equipment to distribution and subdistribution centers.
 5. Submit computer generated point-by-point calculation of parking lot lighting.
 6. Submit lighting level calculations.

1.05 SECTION INCLUDES

- A. Work included in 26 00 00, Electrical Basic Requirements applies to Division 26, Electrical work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of electrical systems for proposed project.
- B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. Definitions:
1. Provide: To furnish and install, complete and ready for intended use.
 2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
 3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
 4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
 5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.06 RELATED SECTIONS

- A. Contents of Section applies to Division 26, Electrical Contract Documents.
- B. Related Work:
1. Additional conditions apply to this Division including, but not limited to:
 - a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - b. Drawings
 - c. Addenda
 - d. Owner/Architect Agreement

- e. Owner/Contractor Agreement
- f. Codes, Standards, Public Ordinances and Permits

1.07 REFERENCES AND STANDARDS

- A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 26, Electrical Sections and those listed in this Section.
- B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 - 1. State of Oregon:
 - a. OAR - Oregon Administrative Rules
 - b. OESC - Oregon Electrical Specialty Code
 - c. OFC - Oregon Fire Code
 - d. OMSC - Oregon Mechanical Specialty Code
 - e. OPSC - Oregon Plumbing Specialty Code
 - f. OSSC - Oregon Structural Specialty Code
 - g. OEESC - Oregon Energy Efficiency Specialty Code
 - h. Oregon Elevator Specialty Code
- C. Reference standards and guidelines include but are not limited to the latest adopted editions from:
 - 1. ABA - Architectural Barriers Act
 - 2. ADA - Americans with Disabilities Act
 - 3. ANSI - American National Standards Institute
 - 4. APWA - American Public Works Association
 - 5. ASCE - American Society of Civil Engineers
 - 6. ASHRAE Guideline 0, the Commissioning Process
 - 7. ASTM - ASTM International
 - 8. CFR - Code of Federal Regulations
 - 9. EPA - Environmental Protection Agency
 - 10. ETL - Electrical Testing Laboratories
 - 11. FCC - Federal Communications Commission
 - 12. FM - FM Global
 - 13. IBC - International Building Code
 - 14. IEC - International Electrotechnical Commission
 - 15. IEEE - Institute of Electrical and Electronics Engineers
 - 16. IES - Illuminating Engineering Society
 - 17. ISO - International Organization for Standardization
 - 18. MSS - Manufacturers Standardization Society
 - 19. NEC - National Electric Code
 - 20. NECA - National Electrical Contractors Association
 - 21. NEMA - National Electrical Manufacturers Association
 - 22. NETA - National Electrical Testing Association
 - 23. NFPA - National Fire Protection Association
 - 24. OSHA - Occupational Safety and Health Administration
 - 25. UL - Underwriters Laboratories Inc.
- D. See Division 26, Electrical individual Sections for additional references.
- E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

- F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

1.08 SUBMITTALS

- A. See Division 01, General Requirements for Submittal Procedures as well as individual Division 26, Electrical Sections.
- B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.
- C. In addition:
1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
 2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via zip file via e-mail. For electronic format, provide one zip file per specification division containing a separate file for each Specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. All transmissions/submissions to be submitted to Architect. Deviations will be returned without review.
 3. Product Data: Provide manufacturer's descriptive literature for products specified in Division 26, Electrical Sections.
 4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the specifications and drawings.
 - a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
 - b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 26, Electrical specification Sections for specific items required in product data submittal outside of these requirements.
 - c. See Division 26, Electrical individual Sections for additional submittal requirements outside of these requirements.
 5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
 6. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer's comments. Identify Engineer's comments and provide an individual response to each of the Engineer's comments. Cloud changes in the submittals and further identify changes which are in response to Engineer's comments.
 7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.

8. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 26, Electrical Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
9. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
10. Substitutions and Variation from Basis of Design:
 - a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
 - b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.
11. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 26, Electrical specification Sections for additional requirements for shop drawings outside of these requirements.
 - a. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
12. Samples: Provide samples when requested by individual Sections.
13. Resubmission Requirements:
 - a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
 - b. Resubmit for review until review indicates no exception taken or "make corrections as noted".
14. Operation and Maintenance Manuals, Owners Instructions:
 - a. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
 - 1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
 - 2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment.

- 3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
 - 4) Include product certificates of warranties and guarantees.
 - 5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
 - 6) Include commissioning reports.
 - 7) Include copy of startup and test reports specific to each piece of equipment.
 - 8) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
- b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 26 00 00, Electrical Basic Requirements, Demonstration.
 - c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.
15. Record Drawings:
- a. Maintain at site at least one set of drawings for recording "As-constructed" conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of conduit, and location of concealed electrical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
 - b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
 - c. At completion of project, input changes to original project on CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
 - d. See Division 26, Electrical individual Sections for additional items to include in record drawings.

1.09 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed to conform with all local, State and Federal codes, and other applicable laws and regulations.
- B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e. distribution equipment, duct banks, light fixtures, etc.) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.
- C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- E. Provide products that are UL listed.

1.10 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

- B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.11 COORDINATION DOCUMENTS

- A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, lights, cable tray and electrical services with architectural and structural requirements, and other trades (including ceiling suspension and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
- B. Advise Architect in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
- C. Verify in field exact size, location, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.
- D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Provide like items from one manufacturer.

2.02 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by state, county, and city authorities. Equipment/fixture supplier is responsible for obtaining State, County, and City acceptance on equipment/fixtures that are not UL approved or are not listed for installation.
- B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
- C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- D. Hazardous Materials:
 - 1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
 - 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 26, Electrical Sections. In the absence of specific requirements, comply with the following:
 - 1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
 - a. Ceiling access panels to be minimum of 24-inch by 24-inch.
 - b. Wall access panels to be minimum of 12-inch by 12-inch.
 - c. Provide two keys for each set of keyed cylinder type locks.
 - d. Manufacturers and Models:

- 1) Drywall: Karp KDW.
- 2) Plaster: Karp DSC-214PL.
- 3) Masonry: Karp DSC-214M.
- 4) 2 hour rated: Karp KPF-350FR.
- 5) Manufacturers: Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Install equipment requiring access (i.e., junction boxes, light fixtures, power supplies, motors, etc.) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in passageways, doorways, scuttles or crawlspace which would impede or block the intended usage.
- C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.
- D. Earthwork:
 1. Confirm Earthwork requirements in Contract Documents. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork Sections. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
 - b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
 - c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.
- E. Firestopping:
 1. Confirm requirements in Division 07, Thermal and Moisture Protection. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- F. Plenums:
 1. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.
- G. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- H. Provide miscellaneous supports/metals required for installation of equipment and conduit.

3.02 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 26 Electrical Sections.
- B. General:

1. Earthquake resistant designs for Electrical (Division 26) equipment and distribution, i.e. power distribution equipment, generators, UPS, etc. to conform to regulations of jurisdiction having authority.
2. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
3. Provide stamped shop drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for conduit and equipment. Submit shop drawings along with equipment submittals.
4. Provide stamped shop drawings from licensed Structural Engineer of seismic flexible joints for conduit crossing building expansion or seismic joints. Submit shop drawings along with seismic bracing details.
5. Provide means to prohibit excessive motion of electrical equipment during earthquake.

3.03 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
 1. Underground conduit installation prior to backfilling.
 2. Prior to covering walls.
 3. Prior to ceiling cover/installation.
 4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
- C. Final Punch:
 1. Prior to requesting a final punch visit from the Engineer, request from Engineer the Electrical Precloseout Checklist, complete the checklist confirming completion of systems' installation, and return to Engineer. Request a final punch visit from the Engineer, upon Engineer's acceptance that the electrical systems are ready for final punch.
 2. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:
 1. During remodeling or addition to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.
 2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new wiring, and wiring to point of connection.
 3. Coordinate transfer time to new service with Owner. If required, perform transfer during off-peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
 - a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 4. No interruption of services to any part of existing facilities will be permitted without express permission in each instance from Owner. Requests for outages must state specific dates, hours and maximum durations, with outages kept to these specific dates, hours and maximum durations. Obtain written permission from Owner for any interruption of power, lighting or signal circuits and systems.
 - a. Organize work to minimize duration of power interruption.
 - b. Coordinate utility service outages with utility company.

3.05 CUTTING AND PATCHING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:
1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
 2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
 3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
 4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and/or walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
 5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.06 EQUIPMENT SELECTION AND SERVICEABILITY

- A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

3.07 DELIVERY, STORAGE AND HANDLING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage and handling to be replaced before installation.
 2. Protect equipment to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
 3. Protect bus duct and similar items until in service.

3.08 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, and individual Division 26, Electrical Sections.
- B. Upon completion of work and adjustment of equipment, test systems and demonstrate to Owner's Representative, Architect, and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.09 CLEANING

- A. Confirm Cleaning requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Upon completion of installation, thoroughly clean electrical equipment, removing dirt, debris, dust, temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

- A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.
- C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- D. Provide miscellaneous supports/metals required for installation of equipment.

3.11 PAINTING

- A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - 1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces (i.e., hangers, hanger rods, equipment stands, etc.) with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
 - 2. In Electrical Room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
 - 3. See individual equipment Specifications for other painting.
 - 4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
 - 5. Conduit: Clean, primer coat and paint interior/exterior conduit exposed in public areas with two coats paint suitable for metallic surfaces. Color selected by Architect.
 - 6. Covers: Covers such as manholes, vaults and the like will be furnished with finishes which resist corrosion and rust.

3.12 DEMOLITION

- A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - 1. It is the intent of these documents to provide necessary information and adjustments to electrical system required to meet code, and accommodate installation of new work.
 - 2. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas. Owner will cooperate to best of their ability to assist in coordinated schedule, but will remain final authority as to time of work permitted.
 - 3. Examination:
 - a. Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to locate and preserve utilities. Replace damaged items with new material to match existing.
 - b. Verify that abandoned wiring and equipment serve only abandoned facilities.

- c. Demolition drawings are based on casual field observation and existing record documents.
 - 1) Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish work.
 - 2) Verify location and number of electrical outlets, luminaires, panels, etc. in field.
 - d. Report discrepancies to Architect before disturbing existing installation.
 - 1) Promptly notify Owner if utilities are found which are not shown on Drawings.
4. Execution:
- a. Remove existing luminaires, switches, receptacles, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless shown as retained or relocated on Drawings.
 - b. Provide temporary wiring and connections to maintain electrical continuity of existing systems during construction. Remove or relocate electrical boxes, conduit, wiring, equipment, and luminaires, as encountered in removed or remodeled areas in existing construction affected by this work.
 - c. Remove and restore wiring which serves usable existing outlets clear of construction or demolition.
 - d. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, provide new conduit and wire to bypass inaccessible junction boxes and abandoned outlets.
 - e. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and wire to reroute clear of construction or demolition and maintain service to existing load.
 - f. Extend circuiting and devices in existing walls to be furred out.
 - g. Remove abandoned wiring to source of supply.
 - h. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
 - i. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
 - j. Disconnect and remove abandoned panelboards and distribution equipment.
 - k. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
 - l. Existing lighting which is to remain, leave luminaires in proper working order.
 - m. Repair adjacent construction and finishes damaged during demolition work.
 - n. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

3.13 ACCEPTANCE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - 1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
 - a. Cleaning
 - b. Operation and Maintenance Manuals
 - c. Training of Operating Personnel
 - d. Record Drawings
 - e. Warranty and Guaranty Certificates
 - f. Start-up/Test Document and Commissioning Reports

3.14 FIELD QUALITY CONTROL

- A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Tests:
 - 1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in operation and maintenance manuals.
 - 2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.15 LETTER OF CONFORMANCE

- A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement that Electrical items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

3.16 SALVAGED EQUIPMENT AND RECYCLED MATERIAL

- A. Salvage the following equipment not being reused and return to Owner:
 - 1. Luminaires
 - 2. Panelboards
 - 3. Breakers
 - 4. Transformers
- B. Electrical equipment that cannot be salvaged for reuse, sell/give to recycling company. Recycle following excess, removed, or demolished electrical material:
 - 1. Copper or aluminum conductors, buses, and motor/transformer windings.
 - 2. Steel and aluminum from raceways, boxes, enclosures, and housings.
 - 3. Acrylic and glass from luminaire lenses/refractors.
- C. Provide separate on-site storage space for recycled and salvaged material. Clearly label space.
- D. Confirm additional salvaged equipment and recycled materials in the Contract Documents.

END OF SECTION

**SECTION 26 05 09
EQUIPMENT WIRING**

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Equipment connections, whether furnished by Owner or other Divisions of the Contract.
 - 2. Equipment grounding.

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition:
 - 1. Verify mechanical and utilization equipment electrical characteristics with Drawings and equipment submittals prior to ordering equipment. Submit confirmation of this verification as a part of, or addendum to, the electrical product submittals.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. Materials and Equipment for Equipment Wiring: As specified in individual Sections.

2.02 GENERAL

- A. Unless otherwise noted, the following voltage and phase characteristics apply to motors:
 - 1. 3/4 HP and Under: 120 volt, 1 phase.
 - 2. 1 HP and Over: 208 volt, 3 phase.
- B. Safety Switches: Provide as required by OESC and as specified in Section 26 28 16, Enclosed Switches and Circuit Breakers.

PART 3 - EXECUTION**3.01 EXAMINATION**

- A. Prior to submittal of product data for electrical distribution equipment, obtain and examine product data and shop drawings for equipment furnished by the Owner and by other trades on the project. Update the schedule of equipment electrical connections accordingly, noting proper ratings for overcurrent devices, fuses, safety disconnect switches, conduit and wiring, and the like. As a minimum, this requirement applies to equipment furnished by Owner and equipment furnished under the following divisions of work under this contract:
 - 1. Division 10, Specialties
 - 2. Division 11, Equipment
 - 3. Division 14, Conveying Equipment
 - 4. Division 21, Fire Suppression
 - 5. Division 22, Plumbing

6. Division 23, HVAC, Heating, Ventilating and Air Conditioning
7. Division 27, Communications
8. Division 28, Electronic Safety and Security

3.02 INSTALLATION

- A. Do not install unrelated electrical equipment or wiring on mechanical equipment without prior approval of Engineer.
- B. Provide moisture tight equipment wiring and switches in ducts or plenums used for environmental air.
- C. Connect motor and appliance/utilization equipment complete from panel to motor/equipment as required by code.
- D. Install motor starters and controllers for equipment furnished by others.
- E. Appliance/Utilization Equipment:
 1. Provide appropriate cable and cord cap for final connection unless equipment is provided with same. Provide receptacle configured to receive cord cap.
 2. Verify special purpose outlet NEMA configuration and ampere rating with equipment supplier prior to ordering wiring devices and coverplates.
- F. ADA Automatic Doors:
 1. Provide control wiring in continuous raceway from door controller unit to manual wall control stations. Provide local switch disconnect for door controller as required by Code.
 2. Coordinate with Division 08, Openings and Drawing requirements.
- G. Motorized Shades and Curtains:
 1. Provide control wiring between remote switch control as shown on Drawings and each shade and curtain motor per manufacturers shop drawings. Provide continuous recessed raceway for control wiring and power to shade and curtain motors. Provide local switch disconnect for each motor as required by Code.
 2. Where photosensor control option is provided, install photosensor for shades as recommended by manufacturer and connect to upstream control panel.
 3. Coordinate with Division 12, Furnishings and Drawings.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Division 01, General Requirements.

3.04 SYSTEMS STARTUP

- A. Provide field representative to prepare and start equipment.
 1. Test and correct for proper rotation of polyphase motors.
- B. Adjust for proper operation within manufacturer's published tolerances.
- C. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION

SECTION 26 05 19**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES****PART 1 - GENERAL****1.01 SUMMARY**

- A. Work Included:
 - 1. Lugs and Pads
 - 2. Wires and Cables
 - 3. Splices
 - 4. Connectors

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Cable insulation test reports in project closeout documentation.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Lugs and Pads:
 - 1. Anderson
 - 2. IlSCO
 - 3. Panduit
 - 4. Thomas & Betts
 - 5. 3M
 - 6. Or approved equivalent.
- B. Wires and Cables:
 - 1. General
 - a. General Cable
 - b. Okonite
 - c. Southwire
 - d. Alcan/Stabiloy
 - e. Nexans/Energex 8000
 - f. Raychem
 - g. Draka Lifeline
 - h. Or approved equivalent.
 - 2. Metal Clad Cable - Type MC:
 - a. Alfex
 - b. AFC
 - c. General Cable

- d. Southwire
- e. Or approved equivalent.
- C. Splices:
 - 1. Branch Circuit Splices:
 - a. Ideal
 - b. 3M Scotchlok
 - c. Uruseal, Inc.
 - d. Or approved equivalent.
 - 2. Feeder Splices:
 - a. Not allowed.
- D. Connectors:
 - 1. Anderson Power Products
 - 2. Burndy
 - 3. IlSCO
 - 4. 3M
 - 5. Thomas & Betts
 - 6. Or approved equivalent.

2.02 LUGS AND PADS

- A. Ampacity: Cross-sectional area of pad for multiple conductor terminations to match ampere rating of panelboard bus or equipment line terminals.
- B. Copper Pads: Drilled and tapped for multiple conductor terminals.
- C. Lugs: Compression type for use with stranded branch circuit or control conductors; mechanical lugs for use with solid branch and feeder circuit conductors.

2.03 WIRES AND CABLES

- A. Copper, 600 volt rated throughout. Conductors 12 AWG and 10 AWG, solid or stranded. Conductors 8 AWG and larger, stranded. 12 AWG minimum conductor size. Minimum insulation rating of 90 degrees C. Insulation Type: THWN-2, XHHW-2 or THHN-2.
- B. Aluminum, 600 volt rated throughout. Conductors 4 AWG and larger, compact stranded. Aluminum Association 8000(AA-8000) Series alloy conductor material built to ASTM B801 specifications. Connectors and terminations to be those listed by Underwriters Laboratories Standard 486-B and marked "AL7CU" for 60C and 75C rated circuits. Connections and terminations to be installed strictly in accordance with manufacturers recommendations.
- C. Phase color to be consistent at feeder terminations; A-B-C, top to bottom, left to right, front to back.
- D. Color Code Conductors as Follows:

PHASE	208 VOLT WYE
A	Black
B	Red
C	Blue
Neutral	White
Ground	Green

- E. MC Cable: Not allowed.
- F. AC Cable (Armored Cable): Not allowed.
- G. NMB Cable: Not allowed.
- H. SO Cord: Annealed copper conductors, 600 volt rated. Minimum size No. 12 AWG with ground wire. Maximum of six conductors and ground per cable. 90 degrees C rated thermoset jacket.

2.04 SPLICES

- A. Feeders:
 - 1. Compression barrel splice with two layers Scotch 23 and four layers Scotch 33+ as vapor barrier.
 - 2. Uraseal Shake N' Seal series splice kits.
- B. Branch Circuits: Twist on, high temperature, grounding type wing nuts.
 - 1. Ideal Industries Wing-Nut Twist-On Connectors.
 - 2. 3M Scotchlok Twist-On Wire Connectors.

2.05 CONNECTORS

- A. Split bolt connectors not allowed.
- B. Aluminum Cable Compression Connections:
 - 1. Provide UL-listed compression lugs that are marked AL7CU or AL9CU and have passed UL 486B or UL 486C testing procedures.
 - 2. Construction: Electro tin plated high conductivity aluminum. Connector marked with wire size, die index, color-coded and the proper number and location of crimps. Factory pre-filled with oxide inhibiting compound.
 - 3. Aluminum cable connection to aluminum bus bar: Use 2-hole aluminum compression lug and aluminum hardware. Apply UL-listed lubricant to hardware and surfaces before tightening.
 - 4. Aluminum cable connection to copper bus bar: Use 2-hole aluminum compression lug, plated steel hardware and Belleville washer. Apply UL-listed lubricant to hardware and surfaces before tightening.
 - 5. Aluminum cable connection to mechanical lugs and equipment identified as not suitable for aluminum conductor termination: Provide aluminum compression lug with stranded copper wire/cable pigtail. Equip lug compression body with insulating cover.
 - 6. Aluminum cable connection to dry-type transformer lugs.
 - 7. Aluminum Termination Hardware:
 - a. Bolts: Anodized alloy 2023-T4 and conforming to ANSI B18.2.1 and to ASTM B211 or B221 chemical and mechanical property limits.
 - b. Nuts: Aluminum alloy 6061-T6 or 6262-T9 and conforming to ANSI B18.2.2.
 - c. Washers: Flat aluminum alloy Alclad 2024-T4, Type A plain, standard wide series conforming to ANSI B27.2. SAE or narrow series washers are not permitted.
- C. Conductor Branch Circuits: Wire nuts with integral spring connectors for conductors 12 AWG through 8 AWG. Push-in type connectors where conductors are not required to be twisted together are not acceptable.
- D. Fluorescent Luminaire Disconnect: polycarbonate housing, tin-plated brass contacts, insulated 18 AWG, factory-installed solid copper leads, 105C temperature rating, UL94-V2 flammability, 4A, 600V. NEC Article 410 compliant. Finger-safe line side. Push-and-click connector.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install per manufacturer instructions and OSSC.
- B. Field Quality Control:
 - 1. Test conductor insulation on feeders of 100 amp and greater for conformity with 1000 volt megohmmeter. Use Insulated Cable Engineers Association testing procedures. Minimum insulation resistance acceptable is 1 megohm for systems 600 volts and below. Notify Architect if insulation resistance is less than 1 megohm.
 - 2. Test Report: Prepare a typed tabular report indicating the testing instrument, the feeder tested, amperage rating of the feeder, insulation type, voltage, the approximate length of the feeder, conduit type, and the measured resistance of the megohmmeter test. Submit test reports with project closeout documents.
 - 3. Inspect and test in accordance with NETA Standard ATS, except Section 4.

4. Perform inspections and tests listed in NETA Standard ATS, Section 7.3.2.

3.02 LUGS AND PADS

- A. Thoroughly clean surfaces to remove all dirt, oil, grease or paint.
- B. Use torque wrench to tighten per manufacturer's directions.

3.03 WIRES AND CABLES

- A. General:
 1. Do not install or handle thermoplastic insulated wire and cable in temperatures below +14 degrees F (-10 C).
 2. Install conductors in raceways having adequate, code size cross-sectional area for wires indicated.
 3. Install conductors with care to avoid damage to insulation.
 4. Do not apply greater tension on conductors than recommended by manufacturer during installation.
 5. Use of pulling compounds is permitted. Clean residue from exposed conductors and raceway entrances after conductor installation. Do not use pulling compounds for installation of conductors connected to GFCI circuit breakers or GFCI receptacles.
 6. Do not use aluminum wire to make connections to mechanical equipment.
 7. Aluminum Conductor Splices, Joints and Terminations:
 - a. Join conductors using compression splice barrels or bolted compression lugs. Terminate conductors using compression lugs. Apply number of compression indents as directed by the manufacturer instructions. Uruseal splice kits are also acceptable.
 8. Conductor Size and Quantity:
 - a. Install no conductors smaller than 12 AWG unless otherwise shown.
 - b. Provide required conductors for a fully operable system.
 9. Provide dedicated neutrals (one neutral conductor for each phase conductor) in all 120V circuits
 - a. Multi-conductor branch circuits fed from single-pole overcurrent protective devices.
 - b. Ground fault protected circuits where a GFCI breaker is used in a panelboard.
 - c. Other electronic equipment which produces a high level of harmonic distortion including, but not limited to, computers, printers, plotters, copy machines, and fax machines.
 10. Conductors in Cabinets:
 - a. Cable and tree wires in panels and cabinets for power and control. Use plastic ties in panels and cabinets.
 - b. Tie and bundle feeder conductors in wireways of panelboards.
 - c. Hold conductors away from sharp metal edges.
 11. Homeruns:
 - a. Do not change intent of branch circuit homeruns without approval. Homeruns for 20A branch circuits may be combined to a maximum of six current carrying conductors including neutral conductors in homeruns. Apply derating factors as required per NEC. Increase conductor size as needed.
 12. Identify wire and cable under the provisions of Section 26 05 53, Identification for Electrical Systems. Identify each conductor with its panel and circuit number as indicated.
 13. Exposed cable is not allowed.
 14. Exposed cable must be run parallel or perpendicular to building lines and hidden from view when possible.
 15. Use of MC Cable is limited to the following conditions. Installations that do not comply with the following conditions are to be removed and replaced with no additional expense to the Owner.
 - a. 20 and 30 amp branch wiring where following conditions apply:
 - 1) Where there is a suspended ceiling with accessible space above (example: suspended acoustic ceiling tile).
 - 2) For drops to ceiling mounted luminaires in areas with accessible ceiling space.

- 3) Do not use for homeruns from branch circuit panel to first device or luminaire in circuit.
- 4) No single run of MC cable longer than 50-feet.

3.04 SPLICES

- A. Make splices complete and promptly after wire installation. Provide single wire pigtails for luminaire and device connections. Wire nuts may be used for luminaire wire connections to single wire circuit conductor pigtails.
- B. Make splices for No. 8 and larger wires with mechanically applied pressure type connectors. Make all taped joints with Scotch 33+ or equal, applied in half-lap layers without stretching to deform. Uraseal splice kits are also acceptable through 250 KCMIL.
- C. For aluminum wire splices and terminations utilize tool applied compression type copper-aluminum lugs containing "Penetrox" or other approved oxidation inhibitor. For aluminum terminations on studs provide properly sized Belleville washers at each lug. For aluminum terminations in set screw lugs on molded case circuit breakers, transfer switches, etc. utilize Burndy type AYP "Hyplug" terminators or Schneider Electric/Square D type VC compression lugs.
- D. Remove insulation with a stripping tool designed specifically for that purpose. A pocket knife is not an acceptable tool. Leave all conductors nick-free.

3.05 CONNECTORS

- A. Install to assure a solid and safe connection.
- B. Do not connect copper and aluminum wiring without UL listed connectors that are listed for the purposes.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Grounding Electrodes
 - 2. Connectors and Accessories
 - 3. Grounding Busbar
 - 4. Grounding Conductor

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Test reports of ground resistance for service and separately derived system grounds.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Comply with the requirements of ANSI/NFPA 70.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Grounding Electrodes:
 - 1. Erico
 - 2. Thomas & Betts
 - 3. Talley
 - 4. Or approved equivalent.
- B. Connectors and Accessories:
 - 1. Burndy Hyground Compression System
 - 2. Erico/Cadweld
 - 3. Amp Ampact Grounding System
 - 4. Pipe Grounding Clamp:
 - a. Burndy GAR Series
 - b. O Z Gedney
 - c. Thomas & Betts
 - d. Or approved equivalent.
- C. Grounding Busbar:
 - 1. Chatsworth
 - 2. Erico
 - 3. Schneider Electric/Square D
 - 4. Panduit

5. Or approved equivalent.
- D. Grounding Conductor
 1. General Cable
 2. Okonite
 3. Southwire
 4. Or approved equivalent

2.02 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, minimum 3/4-inch diameter, 10-foot long, tapered point, chamfered top.

2.03 CONNECTORS AND ACCESSORIES

- A. Grounding Connectors: Hydraulic compression tool applied connectors or exothermic welding process connectors or powder actuated compression tool applied connectors.
- B. Pipe Grounding Clamp: Mechanical ground connector with cable parallel or perpendicular to pipe.

2.04 GROUNDING BUSBAR

- A. Grounding Busbar: 1/4-inch thick by 4-inch high by 10-inch long copper grounding busbar with insulators that meet ANSI J-STD-607-A specifications. UL 467 listed. Hole patterns in busbar to accommodate two-hole lugs, four-hole configuration.

2.05 GROUNDING CONDUCTOR

- A. Grounding Electrode Conductor: Soft-draw bare stranded copper for wire sizes larger than #10 AWG Bare. Solid copper for wire sizes #10 AWG and smaller.
- B. Equipment Grounding Conductor: Green insulated, insulation type to match that of associated feeder or branch circuit wiring, size as indicated on drawings.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Verify site conditions prior to beginning work.
- B. Bond Sections of service equipment enclosure to service ground bus.
- C. Separately Derived Systems: Ground each separately derived system per NEC Article 250.
- D. Corrosion inhibitors: Apply a corrosion inhibitor to contact surfaces when making grounding and bonding connections. Use corrosion inhibitor appropriate for protecting a connection between metals used.
- E. Grounding system resistance to ground not to exceed 5 ohms. Make necessary modifications or additions to grounding electrode system for compliance. Submit final tests to assure that this requirement is met.
- F. Resistance of grounding electrode system: measure using a four-terminal fall-of-potential method as defined in IEEE 81. Take ground resistance measurements before electrical distribution system is energized and in normally dry conditions, not less than 48 hours after last rainfall. Take resistance measurements of separate grounding electrode systems before systems are bonded together below grade. Combined resistance of separate systems may be used to meet required resistance, but specified number of electrodes must still be provided.
- G. Inspect and test in accordance with NETA Standard ATS, Except Section 4.
- H. Perform inspections and tests listed in NETA Standard AB, Section 7.13.

3.02 GROUNDING ELECTRODES INSTALLATION

- A. Ground Rod Electrode:
 1. Verify that final backfill and compaction have been completed before driving rod electrodes.
 2. Bond #6 grounding electrode conductor to driven ground rods as indicated on Drawings.

3. Tap at center ground rod and extend grounding electrode conductor to service grounding bus. Install grounding electrode conductor to service grounding bus in rigid PVC conduit for physical protection where grounding electrode conductor passes through concrete floor or other concrete structure.
- B. Metal Underground Water Service: Bond water service pipe to service equipment ground bus or to the grounding electrode system. Connect to water pipe on utility side of isolating fittings or meters, bond across water meters.
- C. Other Metal Piping Systems: Bond gas piping system, fire sprinkler piping system and other metal piping systems to service equipment ground bus or to the grounding electrode system.
- D. Bond together metal siding not attached to grounded structure; bond to grounding electrode system.

3.03 CONNECTORS AND ACCESSORIES INSTALLATION

- A. Install per manufacturer's instructions.

3.04 GROUNDING BUSBAR INSTALLATION

- A. Install per manufacturer's instructions.

3.05 GROUNDING CONDUCTOR INSTALLATION

- A. Raceways:
 1. Ground metallic raceway systems. Bond to ground terminal with code size jumper except where code size or larger equipment grounding conductor is included with circuit, use grounding bushing with lay-in lug.
 2. Connect metal raceways, which terminate within an enclosure but without mechanical connection to enclosure, by grounding bushings and ground conductor to grounding bus.
 3. Where equipment supply conductors are in flexible metallic conduit, install stranded copper equipment grounding conductor from outlet box to equipment frame.
 4. Install equipment grounding conductor, code size minimum unless noted on drawings, in metallic and nonmetallic raceway systems.
- B. Feeders and Branch Circuits:
 1. Provide continuous green insulated copper equipment grounding conductors for feeders and branch circuits.
 2. Where installed in a continuous solid metallic raceway system and larger sizes are not detailed, provide insulated equipment grounding conductors for feeders and branch circuits sized in accordance with the latest adopted edition of NEC Article 250, Table 250-122.
- C. Bond boxes, cabinets, enclosures and panelboard equipment grounding conductors to enclosure with specified conductors and lugs. Install lugs only on thoroughly cleaned contact surfaces.
- D. Motors, Equipment and Appliances: Install code size equipment grounding conductor to (motor) equipment frame or manufacturer's designated ground terminal.
- E. Receptacles: Connect ground terminal of receptacle and associated outlet box to equipment grounding conductor. Self grounding nature of receptacle devices does not eliminate equipment grounding conductor bolted to outlet box.
- F. Bond electrostatic discharge (ESD) flooring integral grounding conductor to electrically grounded connectors or structures at two opposite locations, in the area of the ESD flooring installation.

END OF SECTION

SECTION 26 05 29**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS AND EQUIPMENT****PART 1 - GENERAL****1.01 SUMMARY**

- A. Work Included:
 - 1. Anchors, Threaded Rod and Fasteners
 - 2. Support Channel, Hangers and Supports
 - 3. Rooftop Conduit Supports

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. Submittals not required for this Section.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.
 - 2. Support systems to be supplied by a single manufacturer.
 - 3. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
 - a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.07 PERFORMANCE REQUIREMENTS

- A. General: Provide conduit and equipment hangers and supports in accordance with the following:
 - 1. When supports, anchorages, and seismic restraints for equipment and supports, anchorages and seismic restraints for conduit, cable tray and equipment are not shown on the Drawings, the Contractor is responsible for their design.
 - 2. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
- B. Engineered Support Systems: The following support systems to be designed, detailed, and bear the seal of a professional engineer registered in the State of Oregon.
 - 1. Support frames such as conduit racks or stanchions for conduit and equipment which provide support from below.
 - 2. Equipment and piping support frame anchorage to supporting slab or structure.

- C. Provide channel support systems, for conduits to support multiple conduits capable of supporting combined weight of support systems and system contents.
- D. Provide heavy-duty steel trapezes for piping to support multiple conduit capable of supporting combined weight of supported systems and system contents.
- E. Provide seismic restraint hangers and supports for conduit and equipment.
- F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Anchors, Threaded Rod and Fasteners:
 - 1. Anchor It
 - 2. Epcon System
 - 3. Hilti-Hit System
 - 4. Power Fast System
 - 5. Or approved equivalent.
- B. Support Channel, Hangers and Supports:
 - 1. B-Line
 - 2. Kindorf
 - 3. Superstrut
 - 4. Unistrut
 - 5. Or approved equivalent.
- C. Rooftop Conduit Supports:
 - 1. Cooper B-Line Dura-Block Rooftop Support Base
 - 2. Or approved equivalent.

2.02 ANCHORS, THREADED ROD AND FASTENERS

- A. Anchors, Threaded Rod and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Concrete Inserts: Cast in concrete for support fasteners for loads up to 800 lbs.
- C. Anchors and Fasteners:
 - 1. Obtain permission from Architect before using powder-actuated anchors.
 - 2. Concrete Structural Elements: Use precast inserts.
 - 3. Steel Structural Elements: Use beam clamps.
 - 4. Concrete Surfaces: Use self-drilling anchors.
 - 5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
 - 6. Solid Masonry Walls: Use expansion anchors.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Wood Elements: Use wood screws.
- D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.
- E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.
- F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

2.03 SUPPORT CHANNEL, HANGERS AND SUPPORTS

- A. Hangers and Supports - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
 - 1. Channel Material: Carbon steel.

- 2. Coating: Hot dip galvanized.
- B. Pipe Straps: Two-hole galvanized or malleable iron.
- C. Luminaire Chain: 90 lb. test with steel hooks.
- D. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on Drawings or otherwise not shown on drawings that are necessary for completion of the project. The Contractor is responsible for their design.
 - 1. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.
- E. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.
- F. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.
- G. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

2.04 ROOFTOP CONDUIT SUPPORTS

- A. Curb base made of 100 percent recycled rubber and polyurethane prepolymer with a uniform load
- B. Capacity of 500 pounds per linear foot of support.
- C. UV resistant.
- D. Steel Frame: Steel, 14 gauge strut galvanized per ASTM A653 or 12 gauge strut galvanized per ASTM A653 for bridge series.
- E. Continuous block channel supports with 1-inch gaps to allow water flow, bridge channel supports, extendable height channel supports and elevated single conduit supports.
- F. Attaching Hardware: Zinc-plated threaded rod, nuts and attaching hardware per ASTM B633 fastened directly into rubber material with weather resistant Type 12 lag screws.
- G. Provide load distribution plates when required for heavy loads.
- H. Finish: Black with safety yellow striping.
- I. Provide hot dipped galvanized components for items exposed to weather.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Fabrication - Miscellaneous Metals
 - 1. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on Drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.
 - 2. Finishes:
 - a. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances

detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with one coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.

- b. **Metal in contact with Concrete, Masonry and Other Dissimilar Materials:** Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
- c. **For Galvanized Surfaces:** Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

3.02 ANCHORS, THREADED ROD AND FASTENERS INSTALLATION

- A. Safety factor of 4 required for every fastening device or support for equipment installed. Supports to withstand four times the weight of equipment it supports.
- B. Do not use other trade's fastening devices as supporting means for luminaires, equipment or materials.
- C. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- D. Do not use supports or fastening devices to support other than one particular item.
- E. Securely suspend junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from floor above or roof structure to prevent sagging and swaying.
- F. Provide seismic bracing per OSSC requirements.
- G. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- H. Use spring lock washers under fastener nuts for strut.
- I. Cutting and Drilling
 - 1. Do not drill or cut structural members without prior permission from Architect.

3.03 SUPPORT CHANNEL, HANGERS AND SUPPORTS INSTALLATION

- A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
- B. Safety factor of 4 required for every fastening device or support for equipment installed. Supports to withstand four times the weight of equipment it supports.
- C. Verify mounting height of luminaires prior to installation when heights are not detailed.
- D. Install vertical support members for equipment and luminaires, straight and parallel to building walls.
- E. Install horizontal support members straight and parallel to ceilings or finished floor unless otherwise noted.
- F. Provide independent supports to structural member for luminaires, materials, or equipment installed in or on ceiling, walls or in void spaces or over suspended ceilings.
- G. Do not use other trade's fastening devices as supporting means for luminaires, equipment or materials.
- H. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- I. Do not use supports or fastening devices to support other than one particular item.
- J. Support conduits within 18-inches of outlets, boxes, panels, cabinets and deflections unless more stringently required by OESC.
- K. Maximum distance between supports not to exceed 8 foot spacing unless otherwise required by OESC.

- L. Support flexible conduits and metal clad cable within 12-inches of outlets, boxes, panels, cabinets and deflections unless otherwise required by OESC.
- M. Maximum distance between supports for flexible conduits and metal clad cable not to exceed 48-inches spacing unless otherwise required by OESC.
- N. Maximum distance between supports for rigid PVC conduits unless otherwise required by OESC is as follows:
 - 1. 1/2-inch or 3/4-inch and 1-inch conduit, 3-feet apart.
 - 2. 1-1/4-inch or 1-1/2-inch and 2-inch conduit, 4-feet apart.
 - 3. 2-1/2-inch and 3-inch conduit, 5-feet apart.
 - 4. 4-inch and 5-inch conduit, 6-feet apart.
 - 5. 6-inch conduit, 7-feet apart.
- O. Maximum distance between supports for auxiliary gutters and wireways unless otherwise required by OESC is as follows:
 - 1. Sheet metal auxiliary gutters and wireways - 4-feet apart horizontally and 10-feet vertically.
 - 2. Non-metallic auxiliary gutters and wireways - 30-inches apart horizontally and 3-feet vertically.
- P. Install strut hangers as instructed by strut manufacturer. Suspend strut hangers as instructed by strut manufacturer for the load, with a maximum spacing of 8-feet on center and within 2-feet of outlet box, cabinet, junction box or other channel raceway termination unless otherwise required by OESC.
- Q. Coordinate routing of conduit racks with materials and equipment installed by other trades. Where conduit racks are exposed to view, coordinate location and installation with Architect for optimal appearance.
- R. Securely suspend junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from floor above or roof structure to prevent sagging and swaying.
- S. Provide seismic bracing per OSSC requirements.
- T. Where service disconnects are mounted on building exterior, physically attach service disconnect to the building or structure served.
- U. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- V. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- W. Wet and Damp Locations:
 - 1. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1-inch off wall.

3.04 ROOFTOP CONDUIT SUPPORTS INSTALLATION

- A. Consult roofing manufacturer for roof membrane compression capacities. If necessary, provide a compatible sheet of roofing material (rubber pad) under rooftop support to disperse concentrated loads and add further membrane protection.
- B. Do not use supports that will void roof warranty.
- C. Install supports per manufacturer's instructions and recommendations.
- D. Use properly sized clamps to suit conduit sizes.
- E. Install supports for rooftop raceways to raise raceways a minimum of 4-inches above the roof structure unless otherwise noted.

END OF SECTION

SECTION 26 05 33
RACEWAYS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Rigid Metal Conduit (RMC)
 - 2. Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Metal Conduit
 - 3. Electrical Metallic Tubing (EMT)
 - 4. Flexible Metal Conduit (FMC)
 - 5. Liquidtight Flexible Metal Conduit (LFMC)
 - 6. Electrical Polyvinyl Chloride (PVC) Conduit
 - 7. Conduit Fittings
- B. Provide a complete system of conduit and fittings, with associated couplings, connectors, and fittings, as shown on drawings and described in these specifications.

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Section 26 05 29, Hangers and Supports for Electrical Systems and Equipment
 - 2. Section 26 05 34, Boxes
 - 3. Section 26 05 43, Electrical Vaults and Underground Raceways

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.07 DEFINITIONS

- A. Raceway system is defined as consisting of conduit, tubing, duct, and fittings including but not limited to connectors, couplings, offsets, elbows, bushings, expansion/deflection fittings, and other components and accessories. Complete electrical raceway installation before starting the installation of conductors and cables.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Rigid Metal Conduit (RMC):
 - 1. Allied Tube & Conduit
 - 2. Beck Manufacturing Inc.
 - 3. Picoma
 - 4. Wheatland Tube Company
 - 5. Or approved equivalent.
- B. Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit:
 - 1. Allied Tube & Conduit

2. Thomas & Betts Corporation
 3. Robroy Industries
 4. O'kote Inc.
 5. Or approved equivalent.
- C. Electrical Metallic Tubing (EMT):
1. Allied Tube & Conduit
 2. Beck Manufacturing WL
 3. Picoma
 4. Wheatland Tube Company
 5. Or approved equivalent.
- D. Flexible Metal Conduit (FMC):
1. AFC Cable Systems Inc.
 2. Electri-Flex Company
 3. International Metal Hose
 4. Or approved equivalent.
- E. Liquidtight Flexible Metal Conduit (LFMC):
1. AFC Cable Systems Inc.
 2. Electri-Flex Company
 3. International Metal Hose
 4. Or approved equivalent.
- F. Electrical Polyvinyl Chloride (PVC) Conduit:
1. AFC Cable Systems Inc.
 2. Electri-Flex Company
 3. International Metal Hose
 4. JM Eagle
 5. Or approved equivalent.
- G. Conduit Fittings:
1. Bushings:
 - a. Insulated type for Threaded Rigid, IMC, or EMT without Factory Installed Plastic Throat Conductor Protection:
 - 1) Thomas & Betts 1222 Series
 - 2) O-Z Gedney B Series
 - 3) Or approved Equivalent.
 2. Raceway Connectors and EMT Couplings:
 - a. Thomas & Betts Series
 - b. O-Z Gedney Series
 - c. Or approved Equivalent.
 3. Expansion/Deflection Fittings:
 - a. EMT: O-Z Gedney Type TX
 - b. RMC: O-Z Gedney Type AX, DX and AXDX, Crouse & Hinds XD
 - c. PVC: O-Z Gedney Type DX with PVC adapters, Carlon E945 Series, Kraloy OPEJ Series
 - d. Or approved equivalent.

2.02 RIGID METAL CONDUIT (RMC)

- A. UL 6, ANSI C80.1. Hot dipped galvanized steel conduit after thread cutting.
1. Fittings: NEMA FB2.10.

2.03 POLYVINYL CHLORIDE (PVC) EXTERNALLY COATED GALVANIZED RIGID METAL CONDUIT

- A. Description: UL 6, ANSI C80.1, and NEMA RN 1; rigid steel conduit with external PVC coating.
1. PVC Coating: Minimum 40 mils in thickness.
- B. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.04 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: UL 797, ANSI C80.3; steel galvanized tubing.
- B. Fittings: NEMA FB 1; steel, set screw type.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: UL 1, Interlocked steel construction.
- B. Fittings: NEMA FB 2.20.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: UL 360, inner core made from spiral wound strip of heavy gauge, hot dipped galvanized low carbon steel. 1/2-inch through 1-1/4-inch trade sizes to have a square lock core and contain an integral bonding strip of copper. 1-1/2-inch and larger to have fully interlocked core. Jacket material to be moisture, oil and sunlight resistant flexible PVC.
- B. Fittings: NEMA FB 2.20.

2.07 ELECTRICAL POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: UL 651, NEMA TC 2; Schedule 40 PVC.
- B. Fittings: NEMA TC 3.

2.08 CONDUIT FITTINGS

- A. Bushings:
 - 1. Insulated type for Threaded Rigid, IMC Conduit or Raceway Connectors without factory-installed plastic throat conductor protection.
 - 2. Insulated grounding type for Threaded Rigid, IMC Conduit and Conduit Connectors.
- B. Raceway Connectors and EMT Couplings:
 - 1. Steel connectors, couplings, and conduit bodies, hot-dip galvanized.
 - 2. Connector locknuts to be steel, with threads meeting ASTM tolerances. Locknuts to be hot-dip galvanized.
 - 3. Connector throats (EMT, flexible conduit, metal clad cable and cordset connectors) to have factory installed plastic inserts permanently installed. For normal cable or conductor exiting angles from raceway, the cable jacket or conductor insulation to bear only on plastic throat insert.
 - 4. Steel gland, Tomic or Breagle connectors and couplings are recognized for this Contract as having acceptable raceway to fitting electrical conductance.
 - 5. Set screw connectors and couplings, without integral compression glands, are recognized for this Contract as not having acceptable raceway to fitting electrical conductance. A ground conductor sized per this Specification must be included and bonded within raceway assembly utilizing this type connector or coupling.
- C. Provide expansion/deflection fittings for EMT.

PART 3 - EXECUTION**3.01 GENERAL INSTALLATION REQUIREMENTS**

- A. Finished Surfaces: Schedule raceway installation to avoid conflict with installed wall and ceiling surfaces. If unavoidable, coordinate work and repairs with Architect.
- B. Conduit Size:
 - 1. Minimum Size: 1/2-inch for power and control, unless otherwise noted. 3/4-inch for communication/data, unless otherwise noted. 3/4-inch for signal systems, unless otherwise noted.
- C. Underground Installations:
 - 1. More than 5-feet from Foundation Wall: Use PVC.
 - 2. Within 5-feet from Foundation Wall: Use PVC coated RMC.
 - 3. In or Under Slab on Grade: Use PVC.
 - 4. Minimum Size: 1-inch.

- D. In Slab Above Grade:
 - 1. Use PVC.
 - 2. Maximum Size Conduit in Slab: Contact Structural Engineer for maximum outside diameter of conduit.
- E. Provide two pull strings/tapes in empty conduits. Types:
 - 1. Utility Company Conduit: Polyester measure/pulling tape, Greenlee 4436 or approved equivalent. Coordinate exact requirements with utility company.
 - 2. Feeders: Polyester measure/pulling tape, Greenlee 4436 or approved.
 - 3. Branch Circuits and Low Voltage: Greenlee Poly Line 431 or approved.
 - 4. If fish tape is used for pulling line or low voltage wiring, fiberglass type to be used. Metal fish tapes will not be allowed.
 - 5. Secure pull string/tape at each end.
 - 6. Provide caps on ends of empty conduit to be used in future.
 - 7. Label both ends of empty conduits with location of opposite end.
- F. Elbows: Use fiberglass or PVC coated RMC for underground installations.
- G. Elbow for Low Energy Signal Systems: Use long radius factory ells where linking sections of raceway for installation of signal cable.
- H. Verify that field measurements are as shown on drawings.
- I. Plan locations of conduit runs in advance of the installation and coordinate with ductwork, plumbing, ceiling and wall construction in the same areas.
- J. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, and walls. Penetrations are acceptable only when the following occurs:
 - 1. Where shown on the structural drawings.
 - 2. As approved by the Structural Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
- K. Verify routing and termination locations of conduit prior to rough-in.
- L. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.
- M. Install raceways securely, in neat and workmanlike manner, as specified in NECA 1, Standard Practices for Good Workmanship in Electrical Construction.
- N. Install steel conduit as specified in NECA 101, Standard for Installing Steel Conduits.
- O. Install nonmetallic conduit in accordance with manufacturer's instructions.
- P. Inserts, anchors and sleeves.
 - 1. Coordinate location of inserts and anchor bolts for electrical systems prior to concrete pour.
 - 2. Coordinate location of sleeves with consideration for other building systems prior to concrete pour.
- Q. Conduit Supports:
 - 1. Arrange supports to prevent misalignment during wiring installation.
 - 2. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
 - 3. Group related conduits; support using conduit rack. Construct rack using steel channel. Provide space on each for 25 percent additional conduits.
 - 4. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
 - 5. Do not attach conduit to ceiling support wires.
- R. Flexible steel conduit length not-to-exceed 6-feet, 3-feet in concealed walls. Provide sufficient slack to reduce the effect of vibration.

- S. Install conduit seals at boundaries where ambient temperatures differ by 10 degrees F or more as shown on the drawings. Install seals on warm side of partition.
- T. Seal raceways stubbing up into electrical equipment. Plug raceways with conductors with duct-seal. Cap spare raceways and plug PVC raceway products with plastic plugs as made by Underground Products, or equal, shaped to fit snugly into the stubup.
- U. Seal raceways penetrating an exterior building wall to prevent moisture and vermin from entering into the electrical equipment.
- V. Use suitable caps on spare and empty conduits to protect installed conduit against entrance of dirt and moisture.
- W. Keep emergency system wiring independent of other wiring systems per NEC 700.
- X. Installation of conduit in structural concrete that is less than 3-inches thick is prohibited without the approval of the Structural Engineer. Maintenance pads, and curbs are exempted.
- Y. Raceways Embedded in Floor Slabs:
 - 1. Do not install raceways in slab without the approval of the Structural Engineer.
 - 2. Do not let raceways interfere with placement of floor slab reinforcement components.
 - 3. Install raceways between the upper and the lower layers of reinforcing steel.
 - 4. Space raceways not less than 8-inches on centers except where they converge at panels or junction boxes.
 - 5. Raceways running parallel to slabs supports, such as beams, columns and structural walls, to be installed not less than 12-inches from such supporting elements.
 - 6. Branch circuit homeruns are not permitted in slab, route branch circuit homeruns above grade exposed in approved areas or above lay-in ceiling spaces.
 - 7. Route conduits in or under slabs point-to-point.
 - 8. Do not cross conduits in slab.
 - 9. Encase medium voltage feeder conduits using red concrete.
- Z. Arrange conduit to maintain headroom and present neat appearance.
- AA. Do not install conduits on surface of building exterior, along vapor barrier, across roof, on top of parapet walls, or across floors, unless otherwise noted on drawings.
- AB. Exposed conduits are permitted only in following areas:
 - 1. Mechanical rooms, electrical rooms or spaces where walls, ceilings and floors will not be covered with finished material.
 - 2. Existing walls that are concrete or block construction.
 - 3. Where specifically noted on Drawings.
 - 4. Route exposed conduit parallel and perpendicular to walls, tight to finished surfaces and neatly offset into boxes.
- AC. Do not install conduits or other electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block area passage's intended usage.
- AD. Install continuous conduit and raceways for electrical power wiring and signal systems wiring.
- AE. Below Grade Conduit:
 - 1. See 26 05 43, Electrical Vaults and Underground Raceways.
 - 2. Use PVC, PVC coated RMC, or fiberglass conduit.
 - 3. Provide watertight conduit sleeves and rubber seals for conduit entering building below grade, Link-Seal system by Thunderline Corporation or approved equivalent.
- AF. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
- AG. Maintain adequate clearance between conduit and piping.
- AH. Keep conduits a minimum of 12-inches away from steam or hot water radiant heating lines (at or above 104 degrees F) or 3-inches away from waste or water lines.
- AI. Cut conduit square using saw or pipecutter; deburr cut ends.
- AJ. Bring conduit to shoulder of fittings; fasten securely.

- AK. Use conduit hubs to fasten conduit to cast boxes in damp and wet locations.
- AL. Install no more than the equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams.
- AM. Use hydraulic one shot bender to fabricate elbows for bends in metal conduit larger than 2-inch size.
- AN. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- AO. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.
- AP. Conduit Terminations for Signal Systems: Provide a plastic bushing on the end of conduit used for signal system wiring.
- AQ. Feeders: Do not combine or change feeder runs.
- AR. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.
- AS. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation and installer.

3.02 RIGID METAL CONDUIT (RMC) INSTALLATION

- A. Outdoor Locations Above Grade: RMC.
- B. In areas exposed to severe mechanical damage: RMC.
- C. For security conduits installed exposed and subject to tampering: RMC.
- D. In hazardous areas per NEC 501: RMC.

3.03 POLYVINYL CHLORIDE (PVC) EXTERNALLY COATED GALVANIZED RIGID METAL CONDUIT INSTALLATION

- A. Use PVC coated RMC 36-inch radius ells for power service conduits and 48-inch radius ells for telephone service conduits.

3.04 ELECTRICAL METALLIC TUBING (EMT) INSTALLATION

- A. Damp Locations: EMT up to 2-inches in diameter.
- B. Dry Locations:
 - 1. Concealed: EMT.
 - 2. Exposed: EMT.
- C. Dry, Protected: EMT.

3.05 FLEXIBLE METAL CONDUIT (FMC) INSTALLATION

- A. Dry Locations: Motors, recessed luminaires and equipment connections subject to movement or vibration, use flexible metallic conduit.
- B. Install 12-inch minimum slack loop on flexible metallic conduit.

3.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) INSTALLATION

- A. Use PVC coated liquidtight flexible metallic conduit for motors and equipment connections subject to movement or vibration and subjected to any of following conditions: Exterior location, moist or humid atmosphere, corrosive environments, water spray, oil, or grease.
- B. Install 12-inch minimum slack loop on liquidtight flexible metallic conduit.

3.07 ELECTRICAL POLYVINYL CHLORIDE (PVC) CONDUIT INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide equipment grounding conductor in PVC conduit runs containing power conductors.
- C. Underground Installation:
 - 1. Areas subject to vehicular traffic: Schedule 80 PVC.

2. Utility primary and secondary conduit: Schedule 80 PVC.
 3. Other underground applications: Schedule 40 PVC, except where prohibited by the NEC or local codes.
- D. Convert PVC conduit to Rigid Metal Conduit (RMC) prior to emerging from underground, concrete encasement, or concrete slab.
 - E. Provide expansion fittings to compensate for expansion and contraction per NEC 352.44.
 - F. PVC elbows are not acceptable. Use fiberglass or PVC coated RMC.
 - G. Trim cut ends inside and outside to remove rough edges.
 - H. Provide bushings when entering a box, fitting or other enclosure.

3.08 CONDUIT FITTINGS INSTALLATION

- A. Conduit Joints: Assemble conduits continuous and secure to boxes, panels, luminaires and equipment with fittings to maintain continuity. Provide watertight joints where embedded in concrete, below grade or in damp locations. Seal metal conduit with metal thread primer. Rigid conduit connections to be threaded, clean and tight (metal to metal). Threadless connections are not permitted for RMC and IMC. Seal conduits where penetrating below raised floor area.
- B. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- C. Use set screw type fittings only in dry locations. When set screw fittings are utilized provide insulated continuous equipment ground conductor in conduit, from overcurrent protection device to outlet.
- D. Use compression fittings in dry locations, damp and rain-exposed locations. Maximum size permitted in damp locations and locations exposed to rain is 2-inches in diameter.
- E. Use threaded type fittings in wet locations, hazardous locations, and damp or rain-exposed locations where conduit size is greater than 2-inches.
- F. Use PVC coated, threaded type fittings in corrosive environments.
- G. Use insulated type bushings with ground provision at switchboards, panelboards, safety disconnect switches, junction boxes that have feeders 60 amperes and greater.
- H. Condulets and Conduit Bodies:
 1. Do not use condulets and conduit bodies in conduits for signal wiring, in feeders 100 amp and larger, or for conductor splicing.
- I. Sleeves and Chases - Floor, Ceiling and Wall Penetrations: Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceilings or walls.
- J. Expansion Joints:
 1. Provide conduits crossing expansion joints where cast in concrete with expansion-deflection fittings, installed per manufacturer's recommendations.
 2. Secure conduits 3-inches and larger to building structure on opposite sides of a building expansion joint with an expansion-deflection fitting across joint installed per manufacturer's recommendations.
 3. Provide conduits less than 3-inches where not cast in concrete with junction boxes securely fastened on both sides of expansion joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits 3-inch and larger may be installed.
 4. Verify expansion/deflection requirements with Structural Engineer prior to installation.
- K. Seismic Joints:
 1. No conduits cast in concrete allowed to cross seismic joint.
 2. Provide conduits with junction boxes securely fastened on both sides of seismic joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line

- length) flexible conduit and copper green ground bonding jumper. Prior to installation, verify with Architect that 15-inches is adequate for designed movement, and if not, increase this length as required.
3. Provide conduits less than 3-inches where not cast in concrete with junction boxes securely fastened on both sides of expansion joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits 3-inch and larger may be installed.
 - L. Provide rigid conduit coupling flush with surface of slab or wall for conduit stubbed in concrete slab or wall to serve electrical equipment or an outlet under table or to supply shop tool, etc. Provide plug where conduit is to be used in future.

END OF SECTION

SECTION 26 05 34
BOXES

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Outlet Boxes
 - 2. Pull and Junction Boxes
 - 3. Box Extension Adapter
 - 4. Conduit Fittings
 - 5. Weatherproof Outlet Boxes
- B. Provide electrical boxes and fittings for a complete installation. Include but not limited to outlet boxes, junction boxes, pull boxes, bushings, locknuts and other necessary components.

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Section 26 05 33, Raceways
 - 2. Section 26 05 53, Identification for Electrical Systems

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Outlet Boxes:
 - 1. Hubbell
 - 2. Thomas & Betts
 - 3. Cooper/Crouse-Hinds
 - 4. Or approved equivalent.
- B. Pull and Junction Boxes:
 - 1. Cooper/Crouse-Hinds
 - 2. Hoffman
 - 3. Or approved equivalent.
- C. Box Extension Adapter:
 - 1. Hubbell
 - 2. Thomas & Betts
 - 3. Cooper/Crouse-Hinds
 - 4. Or approved equivalent.
- D. Conduit Fittings:
 - 1. O-Z Gedney

2. Hubbell
 3. Thomas & Betts
 4. Cooper/Crouse-Hinds
 5. Or approved equivalent.
- E. Weatherproof Outlet Boxes:
1. Pass and Seymour
 2. Hubbell
 3. Thomas & Betts
 4. Cooper/Crouse-Hinds
 5. Intermatic
 6. Or approved equivalent.

2.02 OUTLET BOXES

- A. Luminaire Outlet: 4-inch octagonal box, 1-1/2-inches deep with 3/8-inch luminaire stud if required. Provide raised covers on bracket outlets and on ceiling outlets.
- B. Device Outlet: Installation of one or two devices at common location, minimum 4-inches square, minimum 1-1/2-inches deep. Single- or two-gang flush device raised covers.
- C. Telecom Outlet: Provide 4-inches square, minimum 2-1/8-inch deep box with two-gang plaster ring.
- D. Multiple Devices: Three or more devices at common location. Install one-piece gang boxes with one-piece device cover. Install one device per gang.
- E. Masonry Boxes: Outlets in concrete.
- F. Construction: For interior locations, provide galvanized steel outlet wiring boxes, of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.
- G. Accessories: Provide outlet box accessories for each installation, including mounting brackets, wallboard hangers, extension rings, luminaire studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.
- H. Noise Control: Provide acoustic putty pad to back side of each outlet box installed in acoustic rated walls.

2.03 PULL AND JUNCTION BOXES

- A. Construction: Provide ANSI 49 gray enamel painted sheet steel junction and pull boxes, with screw-on covers; of type shape and size, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.
- B. Location:
 1. Provide junction boxes above accessible ceilings for drops into walls for receptacle outlets from overhead.
 2. Provide junction boxes and pull boxes to facilitate installation of conductors and limiting accumulated angular sum of bends between boxes, cabinets and appliances to 270 degrees.
- C. Fiberglass Handholes: Die molded glass fiber hand holes:
 1. Cable Entrance: Pre-cut 6- x 6-inch cable entrance at center bottom of each side.
 2. Cover: Fiberglass weatherproof cover with nonskid finish.
 3. Cover Legend: ELECTRIC.

2.04 BOX EXTENSION ADAPTER

- A. Construction: Diecast aluminum.
- B. Location: Install over flush wall outlet boxes to permit flexible raceway extension from flush outlet to fixed or movable equipment.

2.05 CONDUIT FITTINGS

- A. Requirements: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and plastic conduit bushings of the type and size to suit each respective use and installation.

2.06 WEATHERPROOF OUTLET BOXES

- A. Construction: Provide corrosion-resistant cast metal weatherproof outlet wiring boxes, of the type, shape and size, including depth of box, with threaded conduit ends, cast metal faceplate with spring-hinged waterproof cap suitably configured for each application, including faceplate, gasket, blank plugs and corrosion proof fasteners. Weatherproof boxes to be constructed to have smooth sides, gray finish.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate locations of floor boxes and wall mounted wiring device boxes with architectural and structural floor plans prior to rough-in.
- B. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1, Standard Practice of Good Workmanship in Electrical Construction.
- C. Secure boxes rigidly to substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.
- D. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NEC. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
- E. Set wall mounted boxes at elevations to accommodate mounting heights specified in this Section.
- F. Electrical boxes are shown on drawings in approximate locations unless dimensioned.
 - 1. Adjust box locations up to 10-feet if required to accommodate intended purpose.
- G. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.
- H. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- I. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- J. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12-inches of box.
- K. Box Color Coding and Marking: Reference Section 26 05 53, Identification for Electrical Systems.
- L. Adjust boxes to be parallel with building lines. Boxes not plumb to building lines are not acceptable.
- M. Install knockout closures in unused box openings.
- N. Clean interior of boxes to remove dust, debris, and other material.
- O. Clean exposed surfaces and restore finish.

3.02 OUTLET BOXES INSTALLATION

- A. Mount outlet boxes, unless otherwise required by ADA, or noted on drawings, following distances above finished floor:
 - 1. Control Switches:
 - a. 48-inches to the top of outlet box.
 - b. 4-inches above top of backsplash at countertops/workstations, not-to-exceed 44-inches above finished floor to the top of outlet box per ADA requirements.
 - 2. Receptacles: 15-inches to the bottom of outlet box.
 - 3. Telecom Outlets: 15-inches to the bottom of outlet box.

4. Other Outlets: As indicated in other sections of specifications or as detailed on drawings.
- B. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6-inches from ceiling access panel or from removable recessed luminaire.
 - C. Flush Outlets in Insulated Spaces: Maintain integrity of insulation and vapor barrier.
 - D. Coordinate electrical device locations and elevations (switches and receptacles) with architectural drawings to prevent mounting devices in mirrors, back splashes, and behind cabinets.
 - E. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
 - F. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices. Adjacent boxes not aligned vertically to be adjusted at no additional cost to Owner.
 - G. Use flush mounting outlet box in finished areas.
 - H. Do not install flush mounting box back-to-back in walls; provide minimum 6-inches separation. Provide minimum 24-inches in acoustic rated walls.
 - I. In acoustical walls, apply acoustic putty pad on outlet box prior to installation of acoustical blanket.
 - J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
 - K. Use stamped steel bridges to fasten flush mounting outlet box between studs.
 - L. Use adjustable steel channel fasteners for hung ceiling outlet box.
 - M. Use gang box where more than one device is mounted together. Do not use sectional box.
 - N. Use gang box with plaster ring for single device outlets.
 - O. Adjust flush-mounting outlets to make front flush with finished wall material.

3.03 PULL AND JUNCTION BOXES INSTALLATION

- A. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- B. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6-inches from ceiling access panel or from removable recessed luminaire.
- C. Do not fasten boxes to ceiling support wires.
- D. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.04 BOX EXTENSION ADAPTER INSTALLATION

- A. Match material to box.
- B. Install gaskets at exterior and wet locations.

3.05 CONDUIT FITTINGS INSTALLATION

- A. Install set-screw fittings so the screws can be seen from below.
- B. Tighten compression fittings per manufacturer's instructions.

3.06 WEATHERPROOF OUTLET BOXES INSTALLATION

- A. Use cast outlet box in exterior locations exposed to weather and wet locations.
- B. Install gaskets.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Equipment Nameplates
 - 2. Device Labels
 - 3. Wire Markers
 - 4. Underground Warning Tape

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals not required for this Section.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
 - 2. Manufacturer's standard products of categories and types required for each application as referenced in other Division 26, Electrical Sections. Where more than a single type is specified for application, provide single selection for each product category.
 - 3. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Equipment Nameplates:
 - 1. B & I Nameplates
 - 2. Intellicum
 - 3. JBR Associates
 - 4. Or approved equivalent.
- B. Device Labels:
 - 1. Kroy
 - 2. Brady
 - 3. Or approved equivalent.
- C. Wire Markers:
 - 1. Brady
 - 2. Panduit
 - 3. Sumitomo
 - 4. Or approved equivalent.
- D. Underground Warning Tape:
 - 1. Allen Systems

2. Brady
3. Or approved equivalent.

2.02 EQUIPMENT NAMEPLATES

- A. Engraved phenolic plastic, laminate, minimum 1/8-inch thick in the size indicated, with beveled edge border matching letter color. Federal specification L-P-387. All upper case letters in engraver standard letter style of the size and wording indicated. Punched for mechanical fastening, except where adhesive mounting is necessary due to substrate. Embossed tape style labels are not acceptable.
- B. Color:
 1. Normal (Utility): White letters on black background.
- C. Letter Size:
 1. Use 1/2-inch letters minimum for identifying major equipment and loads, including switchgear, switchboards, etc.
 2. Use 1/4-inch letters minimum for identifying panels, breakers, etc.
 3. Use 3/16-inch minimum for identifying source, voltage, current, phase, and wire configurations.
- D. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- E. The Architect, Engineer, Commissioning Agent and Owner reserve the right to make modifications to the nameplates as necessary.
- F. Locations:
 1. Switchgear, switchboards, sub-distribution switchboards, distribution panels, and branch panels.
 2. Main breakers and distribution breakers in switchgear, switchboards, and distribution panels.
 3. Equipment including, but not limited to, motor controllers, disconnects, and VFDs.
 4. Low-voltage equipment enclosures including, but not limited to, fire alarm panels, access control panels, and lighting control panels.
 5. Distribution transformers.

2.03 DEVICE LABELS

- A. Label all junction boxes to show system identification, source circuit, or raceway origin. In finished areas, utilize device label. In unfinished areas or above ceilings, use of permanent ink marker is acceptable.

2.04 WIRE MARKERS

- A. Description: Vinyl-cloth self-adhesive type wire markers.
- B. Locations: Each conductor at panelboard gutters, pull boxes, outlet boxes, junction boxes, and each load connection.
- C. Power and Lighting Circuits: Branch circuit or feeder number as indicated on drawings and source panel.
- D. Control Circuits: control wire number indicated on schematic and interconnection diagrams on drawings or shop drawings.

2.05 UNDERGROUND WARNING TAPE

- A. Description: 6-inch wide inert polyethylene plastic tape, 4-mil thick, detectable type, colored per APWA recommendations unless otherwise noted with suitable warning legend describing buried electrical lines.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate designations used on Drawings with equipment nameplates and device labels.
- B. Install nameplates and labels parallel to equipment lines.

- C. Identify empty conduit and boxes with intended use.
- D. Provide typewritten branch panel schedules with protective clear transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designations shown on drawings.
- E. Where changes are made in existing panels, distribution boards, etc., provide new labeling and typewritten schedules to accurately reflect the changes.
- F. Provide color coded boxes as follows:
 - 1. Fire Alarm: Red.

3.02 EQUIPMENT NAMEPLATES

- A. Degrease and clean surfaces to receive nameplates.
- B. Secure equipment nameplates to equipment front using self-tapping stainless steel screws.
- C. Secure equipment nameplates to inside surface of door on panelboard that is recessed in finished locations.
- D. Verify emergency system distribution equipment nameplate colors with Architect/Owner.
- E. Switchgear, switchboards, and panels to include name source, voltage, current phase, wire configuration and fault current rating. Transformers to include source KVA, and secondary voltage, phase, and wire configuration.
- F. Provide nameplates for flush mounted branch panelboards identifying name on front door. On inside of door provide nameplate as noted above. Verify with Architect/Owner if nameplate on outside of door is required.
- G. Provide a second label at branch panelboards listing the means of identification of branch circuit conductors. This identification legend to consist of the color code used for each voltage system (208Y/120V and 480Y/277V). See Specification Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables, for required conductor color code for this project. Include identification of both voltage systems on each label, regardless of the voltage of the panelboard to which the label is affixed. Comply with requirements of NEC 210.5.

3.03 DEVICE LABELS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.
- C. Degrease and clean surfaces to receive labels.

3.04 WIRE MARKERS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.
- C. Provide wire markers on each conductor for power, control, signalling and communications circuits.
- D. Where switches control remote lighting or power outlets, or where switches or outlets in same location serve different purposes, such as light, power, intercom, etc. or different areas, such as corridor and outside, provide plates with 1/8-inch black letters indicating function of each switch or outlet. Also label the function of light switches where two or more are mounted in same locations.

3.05 UNDERGROUND WARNING TAPE

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

- C. Identify underground raceways using underground warning tape. Install one continuous tape per underground raceway at 6- to 8-inches below finish grade. Where multiple underground raceways are buried in a common trench and exceeds 16-inch width, install multiple warning tapes not over 10-inches apart (edge to edge) over the entire group of underground raceways.

END OF SECTION

SECTION 26 05 73
ELECTRICAL DISTRIBUTION SYSTEM STUDIES

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Protective Devices
 - 2. Arc Flash Labels
 - 3. Protective Device Study
 - 4. Short Circuit Study
 - 5. Arc Flash Risk Assessment

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - 2. IEEE 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
 - 3. IEEE 1584, Guide for Performing Arc Flash Calculation.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition provide:
 - 1. Power system studies required under this Section with submittals for electrical equipment, including overcurrent protective devices.
 - 2. Electrical equipment ordered prior to submittal of power system studies are not compliant with these specifications, and are subject to removal and replacement at no cost to Owner where not in compliance with Code and Contract Documents for selective coordination.
 - a. Provide written verification with Stamp or Seal and signature of preparing Engineer.
 - 3. Provide samples of NFPA 70E compliant arc flash hazard labeling for electrical equipment.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Study Preparer Qualifications: Qualified engineer of switchgear manufacturer or approved professional engineer.
 - a. Experienced in preparation of studies of similar type and magnitude.
 - b. Familiar with software analysis products specified.
 - 2. Study Preparer Qualifications: Professional electrical engineer licensed in Project location and not employed by manufacturer of equipment to be provided.
 - 3. Study Preparer Qualifications: Electrical testing agency regularly engaged in short circuit and coordination studies, with at least 5 years experience in work of this type, and employing professional electrical engineer licensed in Project location to perform studies.
 - a. Acceptable Testing Agencies:
 - 1) Emerson.
 - 4. Computer Software for Study Preparation: Use latest edition of commercially available software utilizing specified methodologies.
 - a. Acceptable Software Products:

- 1) EasyPower
 - 2) EDSA Micro Corporation.
 - 3) Operation Technology, Inc; ETAP.
 - 4) SKM Systems Analysis, Inc; Power Tools for Windows.
5. Contractor Responsibility: Provide project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, actual circuit lengths and available fault currents from utility. Provide information in a timely matter to allow studies to be completed prior to release of equipment.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Analyze specific electrical and utilization equipment (according to NEC definition), actual protective devices to be used, and actual feeder lengths to be installed.
1. Scope of Studies: New and existing distribution wiring and equipment, from primary source to buses and branch circuit panelboards.
 2. Primary Source, for Purposes of Studies: Utility company primary protective devices.
 3. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.
 4. Report: State methodology and rationale employed in making each type of calculation; identify computer software package(s) used.
- B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with electrical equipment and wiring to be protected by protective devices; identify nodes on diagrams for reference on report that includes:
1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at main switchboard bus and downstream devices containing protective devices.
 2. Breaker and fuse ratings.
 3. Generator kW and voltage ratings, percent impedance, X/R ratios, and wiring connections.
 4. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
 5. Identification of each bus, with voltage.
 6. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

2.02 PROTECTIVE DEVICES

- A. Provide protective devices of ratings and settings as required so that protective device closest to fault will open first.
- B. Replace existing protective devices to achieve specified performance.
- C. Analyze and determine ratings and settings of protective devices to minimize damage caused by fault and so that protective device closest to fault will open first.
1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
 2. Identify any equipment that is underrated as specified.
 3. Identify specified protective devices that will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost to Owner and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in same frame, time curve characteristics of induction relays, CT ranges, etc.
 4. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve change to contract sum.

5. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.
 6. Do not order, furnish, or install protective devices that do not meet performance requirements unless specifically approved by Engineer.
- D. Protective Device Rating and Setting Chart: Summarize in tabular format required characteristics for each protective device based on analysis; include:
1. Device identification.
 2. Relay CT ratios, tap, time dial, and instantaneous pickup.
 3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
 4. Fuse rating and type.
 5. Ground fault pickup and time delay.
 6. Input level and expected response time at two test points that are compatible with commonly available test equipment and ratings of protective device.
 7. Highlight devices that as furnished by Contractor will not achieve required protection.
- E. Specified equipment has been designed and selected to achieve specified performance; ensure that equipment actually installed provides that performance.
- F. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of system studies.

2.03 ARC FLASH LABELS

- A. Provide label compliant with NFPA 70E guidelines indicating personal protective equipment (PPE) recommended for servicing of electrical equipment while energized, as well as calculated incident energy levels and arc flash protective boundary distance.

2.04 PROTECTIVE DEVICE STUDY

- A. Analyze and determine ratings and settings of protective devices to minimize damage caused by fault and so that protective device closest to fault will open first.
1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
 2. Motors with Solid-State Protective Modules: Select settings for best possible motor protection, taking into consideration actual installed motor torque and current and thermal characteristics.
 3. Identify any equipment that is underrated as specified.
 4. Identify existing protective devices that will not achieve required coordination and cannot be field adjusted to do so.
 5. Identify specified protective devices that will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost to Owner and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in same frame, time curve characteristics of induction relays, CT ranges, etc.
 6. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve change to contract sum.
 7. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.
 8. Do not order, furnish, or install protective devices that do not meet performance requirements unless specifically approved by Architect.
- B. Protective Device Rating and Setting Chart: Summarize in tabular format required characteristics for each protective device based on analysis; include:
1. Device identification.
 2. Relay CT ratios, tap, time dial, and instantaneous pickup.

3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
4. Fuse rating and type.
5. Ground fault pickup and time delay.
6. Input level and expected response time at two test points that are compatible with commonly available test equipment and ratings of protective device.
7. Highlight devices that as furnished by Contractor will not achieve required protection.

2.05 SHORT CIRCUIT STUDY

- A. Calculate fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.
 1. Show fault currents available at key points in system down to fault current of 1,000 A at 208 V.
 2. Include motor contributions in determining momentary and interrupting ratings of protective devices.
 3. Primary Fault Level Assumptions: Obtain data from utility company.

2.06 ARC FLASH RISK ASSESSMENT

- A. Calculate arc flash incident energy (AFIE) levels and flash protection boundary distances to determine required level of personal protective equipment (PPE) at each bus and piece of equipment during normal conditions, emergency power conditions, and other operations that could result in maximum arc flash incident energy levels.
 1. Show flash protection boundary distance.
 2. Include incident energy levels.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Provide services of qualified field engineer and necessary tools and equipment to test, calibrate, and adjust installed protective devices to conform to requirements determined by coordination analysis.
- B. Adjust installed protective devices having adjustable settings to conform to requirements determined by coordination analysis.
- C. Adjust solid-state protective modules for motors prior to applying load to motor.
- D. Submit report showing final adjusted settings of protective devices.

3.02 ELECTRICAL POWER SYSTEM STUDIES

- A. Short Circuit Analysis Study.
 1. Provide complete short circuit study, equipment interrupting and withstand evaluation. Study to include complete electrical distribution system, including contributions from normal source of power without alternative sources of power. Include complete low voltage distribution systems as specified in this Section.
 2. Study Basis: thoroughly cover normal and alternative operation modes that can produce maximum fault conditions, including simultaneous motor contributions.
 3. Perform study in accordance with applicable ANSI/IEEE Standards.
 4. Study Input Data: Utility company short circuit single and three phase contribution, and X/R ratio; resistance and reactance components of each feeder, busway and branch impedance; motor and generator contributions; applicable circuit parameters and contribute to short circuit duty.
 5. Calculate short circuit momentary duties and interrupting duties on basis of maximum available fault current at each switchgear bus, switchboard, motor control center, panelboards, transfer switches, busway plug connection point, dry-type transformer primary and secondary locations, other significant locations throughout system affected by available fault current (including large HVAC units, uninterruptible power supplies, etc.).

6. Perform equipment evaluation study to determine adequacy of overcurrent protection devices by tabulating and comparing short circuit ratings of these devices with available fault current. Notify Owner in writing where problem areas or inadequacies appear in electrical equipment.
 7. Study Report: In bound final report, include sheets listing tabulated information from study, including feeder impedances, motor, utility and generator impedances and fault contributions, and resulting short circuit current including asymmetrical, symmetrical, three, five and eight cycle fault current levels, and line-to-neutral and three-phase-bolted-fault current levels at each calculated point in electrical distribution system.
- B. Protective Device Study:**
1. Perform time-current coordination analysis with aid of computer software intended for this purpose. Include determination of settings, ratings, or types for overcurrent protective devices supplied.
 2. Where necessary, make an appropriate compromise between system protection and service continuity with service continuity considered more important than system protection.
 3. Provide sufficient number of computer generated log-log plots to indicate degree of system protection and coordination by displaying time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
 4. Computer printouts accompany log-log plots and will contain descriptions for each of devices shown, settings of adjustable devices, short-circuit current availability at device location when known, and device identification numbers to aid in locating devices on log-log plots and system one-line diagram.
 5. Study includes separate, tabular computer printout containing suggested device settings of adjustable overcurrent protective devices, equipment where device is located, and device number corresponding to device on system one-line diagram.
 6. Provide computer generated system one-line diagram which clearly identifies individual equipment buses, bus numbers, device identification numbers and maximum available short-circuit current at each bus when known.
 7. Discussion Section which evaluates degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
 8. Call significant deficiencies in protection and/or coordination to attention of Engineer and recommendations made for improvements as soon as they are identified.
 9. Contractor responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in timely manner to allow time-current analysis to be completed prior to final installation.
- C. Arc Flash Risk Assessment:**
1. Perform arc flash risk assessment with aid of computer software intended for this purpose.
 2. Perform arc flash risk assessment in conjunction with short-circuit analysis and time-current coordination analysis.
 3. Submit results of assessment in tabular form, and include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
 4. Perform analysis under worst-case arc flash conditions, and final report describes, when applicable, how these conditions differ from worst-case bolted fault conditions.
 5. Arc flash risk assessment includes recommendations for reducing AFIE levels and enhancing worker safety.
 6. Proposed vendor demonstrates experience with arc flash risk assessment by submitting names of at least ten actual arc flash risk assessments it has performed in past year.
 7. Proposed vendor demonstrates capabilities in providing equipment, services, and training to reduce arc flash exposure and train workers in accordance with NFPA 70E and other applicable standards.

8. Proposed vendor demonstrates experience in providing equipment labels in compliance with OESC and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

END OF SECTION

SECTION 26 09 00
CONTACTORS AND CONTROL DEVICES

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Contactors and Magnetic Controllers
 - 2. Electronic Time Switches
 - 3. Photoelectric Switches

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. UL 924: Standard for Safety of Emergency Lighting and Power Equipment.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Shop Drawings: Submit to NEMA ICS 1 indicating control panel layouts, wiring connections and diagrams, dimensions, support points.
 - 2. Product Data: Provide for each component showing electrical characteristics and connection requirements.
 - 3. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

- A. Warranty of materials and workmanship as outlined in Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Contactors and Magnetic Controllers:
 - 1. Asco
 - 2. Eaton Electrical
 - 3. General Electric
 - 4. Schneider Electric/Square D
 - 5. Or approved equivalent.
- B. Electronic Time Switches:
 - 1. Intermatic
 - 2. Paragon
 - 3. Sangamo
 - 4. Tork
 - 5. Or approved equivalent.
- C. Photoelectric Switches:
 - 1. Precision

2. Paragon
3. Tork
4. Or approved equivalent.

2.02 CONTACTORS AND MAGNETIC CONTROLLERS

- A. Lighting:
 1. Continuously rated 20 amp per pole for types of ballast and tungsten lighting and resistance loads, do not derate for use on high-inrush loads.
 2. Power Contacts:
 - a. Double break, silver cadmium oxide.
 - b. Auxiliary arcing contacts not acceptable.
 - c. Convertible Contacts, N.O. or N.C.
 - d. Contact status, N.O. or N.C., clearly visible.
 3. Approved per UL 508.
 4. Design in accordance with NEMA ICS2-211B, rated for application to 600 volt maximum.
 5. Electrically Held Contactor Coil: Continuously rated and encapsulated.
 6. Mechanically Held Contactor: Encapsulated latch and unlatch coils, coil clearing contacts.
- B. Enclosures: NEMA enclosure suitable for location and use, flush or surface mount as indicated on Drawings.

2.03 ELECTRONIC TIME SWITCHES

- A. Double pole, single throw; one N.O. contact, one N.C. contact. 24 hour digital. Battery power source to provide minimum of 3 years of memory back-up. Eight event setpoints. Provide enclosure with separate hinged door, recessed or surface as indicated on Drawings.

2.04 PHOTOELECTRIC SWITCHES

- A. Characteristics:
 1. Hermetically sealed light sensitive element installed in die cast weatherproof enclosure.
 2. Adjustable external light level slide.
 3. Swivel adjustable enclosure.
- B. Electrical Rating: 120VAC, 1800VA, connected for pilot duty unless otherwise indicated.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Testing:
 1. Test to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings and specifications.
 - a. Daylight sensing automatic lighting controls.
 - b. Occupant sensing automatic lighting controls.
 - c. Automatic time switches for lighting control.
 2. Functionally test all control devices to ensure operation in accordance with approved drawings and specifications.
 3. Prepare and complete report of test procedures and results and file with the Owner.
- B. Install items per manufacturers written instructions.

3.02 CONTACTORS AND MAGNETIC CONTROLLERS

- A. Provide vibration isolation mounting pads for electrically held contactors installed within or on walls which are common to occupied spaces. Isolate terminals and operating mechanisms from enclosure.
- B. Install contactors and relays to reduce noise such that it will not create a disturbance or distraction in the areas in which such equipment is located.

3.03 ELECTRONIC TIME SWITCHES

- A. Install time switches and other automatic control devices in accessible locations near the source of power or grouped at a common location in mechanical rooms or similar spaces.

3.04 PHOTOELECTRIC SWITCHES

- A. Install photoelectric control devices at such locations as necessary to be most effective. Avoid locating photoelectric devices in or at locations where they can be influenced by other than natural light or under eaves. Verify location of equipment with Architect.
- B. Exterior Lighting Control: Control exterior lighting and interior atrium lighting using photoelectric switches to energize contactors controlling lighting circuits. Time clocks used to deenergize lighting at any preset time if desired.

END OF SECTION

SECTION 26 09 23
OCCUPANCY AND VACANCY SENSORS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Occupancy/Vacancy Sensors (Ceiling and Wall mounted)
 - 2. Combined Occupancy Sensor/Wall Switches ("Sensor/Switches")
 - 3. Automatic Switches

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Provide wiring diagrams indicating low voltage and line voltage wiring requirements.
 - 2. Provide, on reproducible architectural floor plan, a layout of sensors indicating their sensing distribution.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Use manufacturer's published testing and adjusting procedures to adjust sensors time delay, daylight sensitivity, and passive infrared sensitivity to satisfaction of the Owner.
 - 2. Prepare and complete report of test procedures and results. Submit these test procedures and results to Owner and Architect.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Occupancy/Vacancy Sensors (Ceiling and Wall mounted):
 - 1. Passive Infrared Occupancy/Vacancy Sensors:
 - a. Sensor Switch
 - b. WattStopper
 - c. Leviton
 - d. Hubbell
 - e. Greengate
 - f. Or approved equivalent.
 - 2. Ultrasonic Occupancy/Vacancy Sensors:
 - a. WattStopper
 - b. Leviton
 - c. Hubbell
 - d. Greengate
 - e. Sensor Switch
 - f. Or approved equivalent.

3. Dual Technology Occupancy/Vacancy Sensors:
 - a. WattStopper
 - b. Leviton
 - c. Hubbell
 - d. Greengate
 - e. Sensor Switch
 - f. Or approved equivalent.
- B. Combined Occupancy/Vacancy Sensor:
 1. Sensor Switch
 2. WattStopper
 3. Leviton
 4. Hubbell
 5. Greengate
 6. Or approved equivalent.
- C. Automatic Switches:
 1. Sensor Switch
 2. WattStopper
 3. Leviton
 4. Hubbell
 5. Greengate
 6. Or approved equivalent.
- D. Basis of Design: Occupancy/Vacancy sensor layout on Drawings are designed based on WattStopper product line. Approved manufacturers listed are allowed on condition of meeting the specified conditions including complete sensor coverage of the area controlled and switching of luminaires in the area controlled. Provide additional sensors and power switch packs as needed to provide the same level of functionality as shown on Drawings or required in Specifications. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.02 GENERAL

- A. Occupancy sensor designation indicates sensors automatically turn lights ON when the sensor detects the presence of a person and will automatically turn lights OFF when no presence is detected for a specified amount of time (automatic-on and automatic-off).
- B. Vacancy sensor designation requires someone to manually turn the lights ON. The sensor will then automatically turn the lights OFF when no presence is detected for a specified amount of time (manual-on and automatic-off).
- C. Provide occupancy sensors to sense presence of human activity within desired space and enable or disable on/off manual lighting control function provided by local switches.
- D. Upon detection of human activity by detector, sensor initiates time delay to maintain lights on for present period of time. Field adjustable time delay setting from 30 seconds to 15 minutes.
- E. Factory set sensors for maximum sensitivity.
- F. LED lamp built into sensor indicates when occupant is detected.
- G. Provide zero cross relay control with sensors and sensor/switched; relay contacts close and open with AC voltage signal is at zero.
- H. Where line voltage sensors and sensor/switches are used, provide to match voltage of controlled circuit.
- I. Line Voltage Sensors, Control Units, and Relays: UL listed.

2.03 OCCUPANCY/VACANCY SENSORS (CEILING AND WALL MOUNTED)

- A. Passive Infrared Sensors:

1. **Sensor Function:** Detects human presence in floor area being controlled by detecting changes in Infrared energy. Sensor detects small movements, i.e., when people are writing while seated at a desk.
 2. Provide temperature compensated dual element pyro-electric sensor and with multi element Fresnel lens.
 3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
 4. Provide daylight filter to ensure that sensor is insensitive to short-wavelength infrared waves, i.e., those emitted by sun.
 5. Adjustments and mounting hardware under removable cover to prevent tampering with adjustments and hardware.
 6. Sensor utilizes advanced digital signal processing technology to reduce false offs without reducing sensitivity.
 7. **Ceiling-Mounted Sensor:**
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. 360 degree sensor range; coverage: 1200 SF, unless otherwise noted on drawings.
 - c. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
 - d. Provide internal form C dry contacts for HVAC control.
 - e. Basis of Design: Wattstopper CI-300 Series.
 8. **Wall-Mounted Sensor:**
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. 90 degree sensor range with dense wide angle lens; coverage: 1000 SF for desktop motion, unless otherwise noted on Drawings.
 - c. Swivel mounting bracket for corner mounting to wall or ceiling.
 - d. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
 - e. Provide internal form C dry contacts for HVAC control.
 - f. Basis of Design: Wattstopper CX Series.
- B. Ultrasonic Occupancy/Vacancy Sensors:**
1. **Sensor Function:** Detects human presence in controlled floor area by detecting Doppler shifts in 40kHz ultrasound created by sensor.
 2. Sensors are precision crystal controlled and do not interfere with each other when two or more are placed in same area. Sensor includes advanced digital signal processing to reduce false on signals without decreasing sensitivity, as well as immunity to RFI/EMI sources.
 3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
 4. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
 5. Provide adjustments and mounting hardware under removable cover to prevent tampering.
 6. **Ceiling-Mounted Sensor:**
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. Maximum protrusion of 1.1-inches and blend in aesthetically with ceiling.
 - c. Coverage: 360 degree sensor range; coverage: 2,000 SF, unless otherwise noted on Drawings.
 - d. Provide internal form C dry contacts for HVAC control.
 - e. Basis of Design: Wattstopper WT Series.
 7. **Ceiling Mounted Sensor - Hallway Sensor Coverage:**
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. Maximum protrusion of 1.5-inches and blend in aesthetically with ceiling.

- c. Coverage: 90 linear feet.
 - d. Provide internal form C dry contacts for HVAC control.
 - e. Basis of Design: Wattstopper UT-300-3 Series.
- C. Dual Technology Sensors:
- 1. Sensor Function: Combined capability of passive infrared with ultrasonic or microphonic technology as described above.
 - 2. Function: Upon a person entering a space, motion must be sensed by both technologies before lighting will be turned on. After this has occurred, detection by either technology will hold lighting on. Sensors retrigger time delay where only one motion is necessary to turn on lights within 5 seconds after turning off.
 - 3. Wall-Mounted Sensor:
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. 90 degree sensor range with dense wide angle lens, coverage; 1000 SF for desktop motion, unless noted on drawings.
 - c. Swivel mounting bracket for corner mounting to wall or ceiling.
 - d. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
 - e. Provide internal form C dry contacts for HVAC control.
 - f. Basis of Design: Wattstopper DT Series.
 - 4. Ceiling-Mounted Sensor:
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. 360 degree sensor range; coverage: 1000 SF for half-step motion, unless otherwise noted on Drawings.
 - c. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
 - d. Provide internal form C dry contacts for HVAC control.
 - e. Basis of Design: Wattstopper DT-300 Series.

2.04 COMBINED OCCUPANCY/VACANCY SENSOR/WALL SWITCHES ("SENSOR/SWITCHES")

- A. Completely self-contained sensor system that fits into standard single gang box. Internal transformer power supply, latching dry contact relay switching mechanism compatible with electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices are not allowed.
- B. Passive infrared sensor technology includes advanced signal processing to reduce false triggers without increasing sensitivity. LED indicator blinks when occupant sensed.
- C. Rated to switch loads: 800 watts incandescent or 120-volt ballast; 1000 watts 277 volt ballast. Zero-crossing technology switches lighting off when AC voltage is at zero, minimizes contact wear.
- D. Provide adjustable daylight feature that holds lighting "off" when desired footcandle level is present.
- E. Provide integral off override switch with no leakage current to load or ground.
- F. Vandal-resistant lens.
- G. Includes neutral wire to meet NEC 2014 Code.
- H. Finish: White.
- I. Alerts for impending shut-off: light flash, audible, both or none.
- J. Standard Sensor/Switch:
 - 1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off). Factory set to manual on/auto off.
 - 2. 180 degree sensor range; coverage: 150 SF for desktop activity.
 - 3. Basis of Design: Wattstopper PW-101 Series.

2.05 AUTOMATIC SWITCHES

- A. Digital Timer Switch:
 - 1. Controls up to 1800 watts at 120 volt, 4100 watts at 277 volt, suitable for ballast and motor loads.
 - 2. Compatible with Decora style faceplate.
 - 3. Provide low voltage (24VAC/VDC) version where used as input to lighting relay panel; includes single-pole, double-throw isolated relay rated for 1A at 30VDC.
 - 4. Electroluminescent LCD display shows timer countdown.
 - 5. Time out setting range from 5 minutes to 12 hours. Lights can be turned off before time-out setting by holding down on/off button.
 - 6. Timer countdown can be reset to beginning by holding down push button for 2 seconds.
 - 7. Zero crossing circuitry.
 - 8. Finish: White.
 - 9. Room lighting flashed and switch beeps 5 minutes and 1 minute prior to switching room lighting off. Either visible or audible features can be disabled.
 - 10. Basis of Design: Wattstopper TS-400 Series.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install occupancy/vacancy sensors as directed by manufacturer's instructions. Complete connections to control circuits, occupancy sensors, power supply pack and low voltage wiring.
- B. Provide power packs for sensor to control number of circuits and/or switch legs within its area of coverage.
- C. Field adjust each sensor to maximize its coverage of room space.
- D. Relocate sensors with ultrasonic technology to avoid being closer to HVAC diffusers and power packs than recommended by manufacturer.
- E. Field set time delay for each device as noted below:
 - 1. Classrooms and Conference Rooms: 30 minutes.
 - 2. Restrooms: 15 minutes.
 - 3. Storage Rooms, Janitor's Closets, Unisex Restrooms: 5 minutes.
 - 4. All Other Spaces: 15 minutes.
 - 5. Time Switches: 2-hours.
- F. Prior to applying dimming controls, maintain fluorescent lighting at full output for minimum of 100 hours. If this is not done, replace lamps and ballasts of affected luminaires at no cost to Owner.
- G. Coordinate HVAC control requirements with controls contractor prior to installation.
- H. Lighting System Testing and Commissioning:
 - 1. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.
 - 2. Testing includes:
 - a. Daylight Automatic Controls
 - b. Occupant Sensing Automatic Controls
 - c. Automatic Time and Override Controls for Interior Lighting
 - d. Automatic Time and Photo Controls for Exterior Lighting

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Power Distribution Panelboards
 - 2. Panelboards

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Section 26 05 73, Electrical Distribution System Studies.
 - 2. Section 26 24 13, Switchboards.
 - 3. Section 26 28 00, Overcurrent Protective Devices.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. UL 67, Standards for Panelboards.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Power Distribution Panelboards:
 - 1. Eaton
 - 2. General Electric
 - 3. Siemens
 - 4. Schneider Electric/Square D
 - 5. Or approved equivalent.
- B. Panelboards:
 - 1. Eaton
 - 2. General Electric
 - 3. Siemens
 - 4. Schneider Electric/Square D
 - 5. Or approved equivalent.
- C. Manufacturers listed above are allowed on condition of meeting specified conditions including available space for equipment, Code required working clearances, and selective coordination per Section 26 05 73, Electrical Distribution System Studies. Prior to submitting bid, manufacturer to provide documentation to Engineer verifying specific conditions, including those mentioned above, can be met. Remove and replace electrical equipment installed, at no cost to the Owner, that does not meet these conditions.

- D. Basis of Design: Schneider Electric/Square D. Manufacturers listed are allowed on condition of meeting specified conditions including available space for the equipment and Code required working clearances, and selective coordination per Section 26 05 73, Electrical Distribution System Studies. Remove and replace electrical equipment installed that does not meet these conditions at no cost to Owner.

2.02 POWER DISTRIBUTION PANELBOARDS

- A. Description: NEMA PB 1 Type 1, circuit breaker type.
- B. Integrated Equipment Rating: Provide fully rated integrated equipment rating greater than the available fault current. Series rated panelboards are not acceptable. Reference drawings for available fault current. If drawings do not have available fault current shown, then coordinate with serving electrical utility. Final rating based on the protective device study completed under the provisions of Division 26, Electrical Distribution System Studies.
- C. Panelboard Bus: Non-reduced Aluminum, ratings as indicated on drawings. Bus bar with suitable electroplating (tin) for corrosion control at connection. Provide copper ground bus in each panelboard.
- D. Lugs: Mechanical type for copper conductors.
- E. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.
- F. Molded Case Circuit Breakers with Current Limiters: With replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole; UL listed.
- G. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.
- H. Circuit breakers 1200 Amp and Greater: Provide breaker with energy-reducing maintenance switching with local status indicator per NEC Article 240.87(B).
- I. Fully equip unused spaces for future devices, including manufacturer required connections and mounting hardware.
- J. Cabinet Front: Surface type hinged door with flush lock, door-in-door construction, metal directory frame finished in manufacturer's standard gray enamel.

2.03 PANELBOARDS

- A. Description: Panelboards 400 amps or less. NEMA PB1, Type 1 as indicated on drawings, circuit breaker type. Maximum enclosure depth: 6-inches for surface mounted, 5 3/4-inches for flush mounted.
- B. Maximum Width: 20-inches.
- C. Integrated Equipment Rating: Provide fully rated integrated equipment rating greater than the available fault current. Series rated panelboards are not acceptable. Reference drawings for available fault current. If drawings do not have available fault current shown, then coordinate with serving electrical utility. Final rating based on the protective device study completed under the provisions of Division 26, Electrical Distribution System Studies.
- D. Panelboard Bus Non-Reduced: Aluminum, ratings as indicated on drawings. Bus bar with suitable electroplating (tin) for corrosion control at connection. Provide copper ground bus in each panelboard.
- E. Lugs: Mechanical type for conductors.
- F. Provide double lugs and/or feed-through lugs for feed through feeders.
- G. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for poles; UL listed. Predrill bus for bolt-on breakers.
 - 1. Type SWD for lighting circuits.
 - 2. Type HACR for air conditioning equipment circuits.
 - 3. Class A ground fault interrupter circuit breakers where scheduled.

4. Class B ground fault equipment protection circuit breakers for heat trace and other circuits as required by Code. Provide shunt trip circuit breakers where scheduled; provide wiring to remote trip switch/contacts as indicated on Drawings.
 5. Do not use tandem circuit breakers.
- H. Accessories: Provide where indicated: shunt trip, arc-fault circuit interrupter (AFCI), Class A ground fault circuit interrupter (GFCI), auxiliary switch and alarm switch.
 - I. Cabinet Front: Provide flush or surface mounting as shown on the schedules, drawings, or otherwise noted. Cabinet front with concealed hinged front cover door-in-door construction, metal directory frame with heavy clear plastic protector, flush lift latch and lock, two keys per panel all keyed alike.
 - J. Provide boxes with removable blank end walls and interior mounting studs. Provide interior support bracket for ease of interior installation.
 - K. Furnish surface mounted cabinet boxes without knockouts.
 1. Minimum Integrated Short Circuit Rating:
 - a. 10,000 amperes symmetrical for 240 V panelboards.
 - b. Minimum rating as indicated on the Drawings or Panel Schedules.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install panelboards in accordance with NEMA PB 1.1, NECA 1 and manufacturers installation instructions.
- B. Install panelboards level and plumb. Install recessed panelboards flush with wall finishes.
- C. Height: 6-feet 6-inches to top of panelboard; install panelboards taller than 6-feet 6-inches 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. Include all "spaces" and "spares." Revise directory to reflect circuiting changes and as-installed conditions. Use final Owner designated room names and numbers, and not designations shown on drawings.
- F. Provide engraved plastic nameplates per Section 26 05 53, Identification for Electrical Systems.
- G. Provide arc flash labels per Section 26 05 73, Electrical Distribution System Studies.
- H. Provide three, 1-inch spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
- I. Provide permanent identification number in or on panelboard dead-front adjacent to each breaker pole position. Horizontal centerline of numbers to correspond with centerline of circuit breaker pole position.
- J. Ground and bond panelboard enclosure per NEC.
- K. Paint:
 1. Standard factory finish unless noted otherwise.
 2. Panelboards located in finished interior areas in view of building occupants; paint to match adjacent wall surface. Color and paint preparation as specified by Architect. Covers to be painted off wall, then installed over dried, painted wall surface.
- L. Provide handle guards on each circuit supplying obviously constant loads such as fire alarm, security, lighting controls, refrigerators and freezers, fire protection, etc.
- M. Provide interior wiring diagram, neutral wiring diagram, UL label, and short circuit rating on interior or in booklet format inserted in sleeve inside panel cover.
- N. Verify available recessing depth and coordinate wall framing with other divisions.
- O. Maintain fire rating of wall where panels are installed flush in fire rated walls.
- P. Perform inspections and tests in accordance with manufacturer's requirements.

- Q. Thoroughly clean exterior and interior of each panelboard in accordance with manufacturer's installation instructions.
- R. Vacuum construction dust, dirt, and debris out of each panelboard.
- S. Where enclosure finish is damaged, touch up finish with matching paint in accordance with manufacturer's specifications and installation instructions.

3.02 POWER DISTRIBUTION PANELBOARDS INSTALLATION

- A. Breakers being added to existing panelboards: Coordinate breaker type and short circuit rating with existing panelboard. Breakers to match existing in manufacturer's type and AIC rating. Provide new typed circuit directory.
- B. Provide handle tie to branch circuit breakers of multiwire branch circuits for simultaneous disconnection of circuits. Handle tie will be identified for use with circuit breakers provided. Reconfigure assigned circuits as necessary so that circuit breakers associate with multiwire branch circuits are physically adjacent, record changes in panelboard schedules and circuiting plans for record drawings.
- C. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.
- D. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

3.03 PANELBOARDS INSTALLATION

- A. Breakers being added to existing panelboards: Coordinate breaker type and short circuit rating with existing panelboard. Breakers to match existing in manufacturer's type and AIC rating. Provide new typed circuit directory.
- B. Provide handle tie to branch circuit breakers of multiwire branch circuits for simultaneous disconnection of circuits. Handle tie will be identified for use with circuit breakers provided. Reconfigure assigned circuits as necessary so that circuit breakers associate with multiwire branch circuits are physically adjacent, record changes in panelboard schedules and circuiting plans for record drawings.
- C. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.
- D. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included: Provision of materials, installation and testing of:
 - 1. Wall Switches
 - 2. Receptacles
 - 3. Finish Plates
 - 4. Wall Dimmers
 - 5. Surface Covers

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Wall switches and Dimmers
 - 2. Receptacles
 - 3. Wall Plates
 - 4. In-Use Cover

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Wall Switches:
 - 1. Toggle Type Characteristics:
 - a. Cooper AH1201
 - b. Hubbell HBL1221
 - c. Leviton 1221
 - d. Legrand P&S PS20AC1
 - e. Or approved equivalent.
- B. Receptacles:
 - 1. Industrial Grade:
 - a. Cooper 5362
 - b. Hubbell HBL5362
 - c. Bryant BRY5362
 - d. Leviton 5362
 - e. Legrand P&S 5362A
 - f. Or approved equivalent.
 - 2. Commercial Grade:
 - a. 20 Amp:

- 1) Cooper 5362
 - 2) Hubbell 5362
 - 3) Bryant CBR520
 - 4) Leviton 5362S
 - 5) Legrand P&S 5362
 - 6) Or approved equivalent.
3. Ground Fault Circuit Interrupter (GFCI) Receptacle:
 - a. Cooper TWRSGF20
 - b. Hubbell GFTWRST20
 - c. Legrand P&S 2097TRWR
 - d. Or approved equivalent.
 4. Specification Grade Tamper-Resistant Duplex - 20 Amp:
 - a. Cooper TR5362
 - b. Hubbell BR20TR
 - c. Leviton TBR20
 - d. Legrand P&S TR5362
 - e. Or approved equivalent.
- C. Finish Plates:
1. Bryant
 2. Cooper
 3. Hubbell
 4. Leviton
 5. Legrand P&S
 6. Or approved equivalent.
- D. Wall Dimmers:
1. Lutron Maestro Series
 2. Or approved equivalent.
- E. Surface Covers:
1. Aluminum with Gasket, Blanks, Single Gang:
 - a. Bell 240-ALF
 - b. Carlon
 - c. Or approved equivalent.
 2. 2-Gang:
 - a. Bell 236-ALF
 - b. Carlon
 - c. Or approved equivalent.
 3. While-in-Use Weatherproof Cover:
 - a. UV Stabilized Polycarbonate Cover:
 - 1) Legrand P&S
 - 2) Intermatic
 - 3) Hubbell
 - 4) Cooper
 - 5) Or approved equivalent.
- F. Provide lighting switches and receptacles of common manufacturer and appearance.

2.02 WALL SWITCHES

- A. Characteristics: Toggle type, quiet acting, 20 amp, 120/277 volt, UL listed for motor loads up to 80 percent of rated amperage, extra heavy duty.
- B. Finish: Match Building Standard.

2.03 RECEPTACLES

- A. Duplex Receptacles Characteristics: Straight parallel blade, 125 volt, 2 pole, 3 wire grounding.

1. Commercial Grade: Riveted. Back and side wired. Brass ground contact on steel strap. Nylon face and nylon base. 20 amp.
- B. Ground Fault Circuit Interrupter (GFCI) Receptacle: Feed through type, back-and-side wired, tamper-resistant, weather resistant self-testing, 20 amp, 125VAC.
- C. Special Purpose Receptacles: Reference Drawings for NEMA Standard Specification.
- D. Finish:
 1. Same exposed finish as switches.
 2. Receptacles installed in surface raceway to match raceway finish. See Section 26 05 33, Raceways.

2.04 FINISH PLATES

- A. Finish Plates: Match building standard
- B. Provide telephone/signal device plates; activated outlets to have coverplates to match modular jack.

2.05 WALL DIMMERS

- A. Provide wall dimmers compatible with type of load controlled (i.e. line voltage, low voltage, 2-wire, 3-wire, 0-10v). Finish to match wall switches. Size dimmers to accept connected load. Do not cut fins. Where dimmers are ganged together, provide a single multi gang coverplate.
- B. LED indicator dots show by what percentage controlled lighting is dimmed. Programmable settings for maximum and minimum trim settings, and rate of change in lighting levels.

2.06 SURFACE COVERS

- A. Material: Galvanized steel, 1/2-inch raised industrial type with openings appropriate for devices installed on surface receptacles.
- B. Cast Box and Extension Adaptors: Aluminum with gasket, blanks single gang or 2-gang.
- C. While-in-Use Weatherproof Cover: NEMA 3R when closed over energized plug. Vertical mount for duplex receptacle. Provide continuous use cover with cover capable of closing over energized cord cap with bottom aperture for cord exit.
 1. UV stabilized polycarbonate cover with closed cell neoprene foam gasket.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. See Architectural elevations for location and mounting height of wiring devices. Review Architectural elevations prior to rough-in and contact Architect immediately if conflicts are found between Architectural and Electrical Drawings. Do not rough-in devices until conflicts are resolved.
- B. Install wiring devices and finish plates plumb with building lines, equipment cabinets and adjacent devices. Devices not plumb will be fixed at no additional cost to Owner.
- C. Orientation:
 1. Install wiring devices with long dimension oriented vertically at centerline height shown on drawings or as specified.
 2. Vertical Alignment: When more than one device is shown on drawings in close proximity to each other, but at different elevations, align devices on a common vertical center line for best appearance. Verify with Architect.
 3. Horizontal Alignment: When more than one device is shown on drawings in close proximity to each other with same elevation, align devices on a common horizontal center line for best appearance. Verify with Architect.
- D. Provide labeling per Section 26 05 53, Identification for Electrical Systems.
- E. Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

3.02 WALL SWITCHES INSTALLATION

- A. At time of substantial completion, replace those items which have been damaged.

3.03 RECEPTACLES INSTALLATION

- A. Upon installation, adhere to proper and cautious use of convenience receptacles. At time of substantial completion, replace those items which have been damaged, including those burned and scored by faulty receptacles or cord caps.
- B. GFCI Receptacles: One GFCI receptacle may not be used to provide GFCI protection to downstream duplex receptacles on the same branch circuit.
- C. As required by OESC in areas with young children, provide tamper resistant receptacles.

3.04 FINISH PLATES INSTALLATION

- A. Do not install items until finish painting is complete. Replace scratched and paint splattered finish plates and wiring devices.

3.05 WALL DIMMERS INSTALLATION

- A. Install per manufacturer's recommendations and wiring diagrams.

3.06 SURFACE COVERS INSTALLATION

- A. Do not install items until finish painting is complete. Replace scratched and paint splattered finish plates and wiring devices.

END OF SECTION

SECTION 26 28 00
OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Fuses
 - 2. Molded Case Circuit Breakers
 - 3. Fuse Cabinets

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Product data and instantaneous let-through current curves and average melting time current curves for fuses supplied to project.
 - 2. Product data and time/current trip curves for circuit breakers supplied to project.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Fuses:
 - 1. Bussmann
 - 2. Ferraz-Shawmut
 - 3. Littelfuse
 - 4. McGraw-Edison
 - 5. Or approved equivalent.
- B. Molded Case Circuit Breakers:
 - 1. Eaton Electrical
 - 2. General Electric
 - 3. Siemens
 - 4. Schneider Electric/Square D
 - 5. Or approved equivalent.
- C. Fuse Cabinet:
 - 1. Bussmann
 - 2. Circle AW
 - 3. Ferraz-Shawmut
 - 4. Littelfuse
 - 5. Siemens
 - 6. Schneider Electric/Square D
 - 7. Or approved equivalent.

2.02 FUSES

- A. Characteristics:
 - 1. Dual element, time delay, current limiting, nonrenewable type, rejection feature.
 - 2. Combination Loads: UL Class RK1, 1/10 to 600 amp. UL Class L, above 600 amps.
 - 3. Motor Loads: UL Class RK5, 1/10 to 600 amp.
 - 4. Fuse pullers for complete range of fuses.

2.03 MOLDED CASE CIRCUIT BREAKERS

- A. 1-, 2- or 3-pole bolt-on, single handle common trip, 600VAC or 250VAC as indicated on Drawings.
- B. Overcenter toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
- C. Calibrate for operation in 40 degrees C ambient temperature.
- D. 15 to 150 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.
- E. 151 to 400 Amp Breakers: Adjustable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.
- F. Greater than 401 Amp: Electronic trip type with adjustments for long-time, instantaneous, and short-time functions.
- G. Circuit breakers 1200 Amp and Greater: Provide breaker with energy-reducing maintenance switching with local status indicator per NEC Article 240.87(B).
- H. Provide ground fault function for breakers greater than 800 amps where applied at 480 volts line-to-line; and where indicated on drawings.

2.04 FUSE CABINET

- A. Enclosure:
 - 1. Metallic cabinet surface mounted, with internal shelves, trim cover with hinged and latched door.
 - 2. Size cabinet such that spare fuses required by these Documents do not exceed 50 percent of cabinet volume.
- B. Label: Provide engraved label to identify as spare fuse cabinet.

PART 3 - EXECUTION**3.01 GENERAL INSTALLATION REQUIREMENTS**

- A. Coordination:
 - 1. Obtain and review the submitted product data for equipment furnished by the Owner, and furnished under other Divisions of this contract, particularly under Divisions 22 and 23.
 - 2. Confirm the equipment nameplate maximum overcurrent protection (MOCP) and make accommodations and adjustments to overcurrent protective devices as necessary to coordinate with the nameplate rating.
- B. Install all items in accordance with manufacturers written instructions.

3.02 FUSES

- A. Fuses: For each class and ampere rating of fuse installed, provide the following quantities of spares for quantity of fuses installed:
 - 1. 0 to 24: Provide 6 spare.
 - 2. 25 to 48: Provide 9 spare.
 - 3. 49 and Above: Provide 12 spare.

3.03 MOLDED CASE CIRCUIT BREAKERS

- A. Provide testing of ground fault interrupting breakers.
- B. Provide circuit breakers, as specified and on Drawings, for installation in panelboards, individual enclosures or combination motor starters.

- C. Provide ground fault interrupter circuit breakers for equipment in damp or wet locations.
- D. Provide device on handle to lock breaker in "ON" position for breakers feeding time switches, night lights and similar circuits required to be continuously energized.
- E. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.
- F. Provide multi-pole branch circuit breakers for multiwire branch circuits for simultaneous disconnection of circuits.

3.04 FUSE CABINETS

- A. Install fuse cabinet on wall in the Electrical Room in coordination with electrical equipment.

END OF SECTION

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Toggle Type Disconnect Switches
 - 2. Manual Motor Starters
 - 3. Safety Switches
 - 4. Enclosed Circuit Breakers
 - 5. Molded Case Switches

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Section 26 05 73, Electrical Distribution System Studies.
 - 2. Section 26 24 13, Switchboards.
 - 3. Section 26 24 16, Panelboards.
 - 4. Section 26 28 00, Overcurrent Protective Devices.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Toggle Type Disconnect Switches:
 - 1. Cooper
 - 2. Hubbell
 - 3. Leviton
 - 4. Pass & Seymour
 - 5. Slater
 - 6. Or approved equivalent.
- B. Manual Motor Starters:
 - 1. Eaton Electrical
 - 2. General Electric
 - 3. Siemens
 - 4. Schneider Electric/Square D
 - 5. Or approved equivalent.
- C. Safety Switches:
 - 1. Eaton Electrical
 - 2. GE Industrial
 - 3. Siemens

4. Schneider Electric/Square D
 5. Or approved equivalent.
- D. Enclosed Circuit Breakers:
1. Eaton Electrical
 2. GE Industrial
 3. Siemens
 4. Schneider Electric/Square D
 5. Or approved equivalent.
- E. Molded Case Switches:
1. Eaton Electrical
 2. General Electric
 3. Siemens
 4. Schneider Electric/Square D
 5. Or approved equivalent.

2.02 TOGGLE TYPE DISCONNECT SWITCHES

- A. Rating: 120 or 208 volt, 1 or 2 pole, 20 amp, 1 hp maximum.
- B. Enclosure:
1. NEMA 1: Dry locations/Indoors.
 2. NEMA 3R: Damp or wet locations/Outdoors.
- C. Handle lockable in 'off' position.

2.03 MANUAL MOTOR STARTERS

- A. Quick-Make, Quick-Break. Thermal overload protection. Device labeled with maximum voltage, current, and horsepower.
- B. Enclosure:
1. NEMA 1: Dry locations/Indoors.
 2. NEMA 3R: Damp or wet locations/Outdoors.

2.04 SAFETY SWITCHES

- A. Heavy duty fusible type and non-fusible type (as indicated on drawings), dual rated, quick-make, quick-break with fuse rejection feature for use with Class R fuses only, unless other fuse type is specifically noted.
- B. Clearly marked for maximum voltage, current, and horsepower.
- C. Operable handle interlocked to prevent opening front cover with switch in 'on' position.
- D. Switches rated for maximum available fault current.
- E. Handle lockable in 'off' position.
- F. Enclosure:
1. NEMA 1: Dry locations/Indoors.
 2. NEMA 3R: Damp or wet locations/Outdoors.
- G. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Provide fuse rejection feature for Class R fuses up to 600 amp. Remove if circuit breaker type is used. Provide switches of 30 to 200 amp with plug-on line side connections.
- H. Fusible Switch Assemblies, 800 Amperes and Larger: Bolted pressure contact switches. Fuse Clips: Designed to accommodate Class L fuses. Provide with shunt-trip and ground fault capabilities. Remove if circuit breaker type is used.

2.05 ENCLOSED CIRCUIT BREAKERS

- A. Molded case circuit breakers:
1. 1-, 2-, or 3-pole bolt on, single-handle common trip, 250VAC as indicated on drawings.

2. Overcenter toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
 3. Calibrate for operation in 40C ambient temperature.
 4. 15 to 150 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.
 5. 151 to 400 Amp Breakers: Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.
 6. Greater than 401 Amp: Electronic trip type with adjustments for long-time, instantaneous, and short-time functions. Provide ground fault function for breakers greater than 400 amps.
 7. Provide handle mechanisms that are lockable in the open (off) position.
 8. Circuit breakers to have minimum symmetrical interrupting capacity as indicated on Drawings.
 9. Where protective devices are applied in series combination, such that the prospective available fault current exceeds the interrupting rating (AIR) of the downstream protective devices, such combinations to be UL recognized combinations. Electrical equipment using these UL recognized circuit breaker combinations to be clearly marked in accordance with NEC Section 240.86 and 110.22.
- B. Enclosure:
1. NEMA 1: Dry locations/Indoors.
 2. NEMA 3R: Damp or wet locations/outdoors.

2.06 MOLDED CASE SWITCHES

- A. Removable cover, galvanized steel enclosure, powder coat painted.
- B. Provide cover padlock provision.
- C. Provide trip unit with no overcurrent, overload, or low level fault protection. Trip unit to be high instantaneous magnetic fixed trip type with magnetic trip reset at factory to interrupt high fault currents at or above preset level.
- D. Enclosure:
1. NEMA 1: Dry locations/Indoors.
 2. NEMA 3R: Damp or wet locations/Outdoors.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Obtain and review the submitted product data for equipment furnished by the Owner, and furnished under other Divisions of this contract, particularly under Divisions 22 and 23.
- B. Confirm the equipment nameplate maximum overcurrent protection (MOCP) and make accommodations and adjustments to switches, fuses and circuit breakers as necessary to coordinate with the nameplate rating
- C. Install in accordance with manufacturer's instructions.
- D. Provide engraved nameplates per Section 26 05 53, Identification for Electrical Systems.
- E. Provide arc flash labels per Section 26 05 73, Electrical Distribution System Studies.
- F. Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.

3.02 TOGGLE TYPE DISCONNECT SWITCHES

- A. Install fuses in fusible disconnect switches. Coordinate fuse ampere rating with installed equipment. Do not provide fuses of lower ampere rating than motor starter thermal units.
- B. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- C. See General Installation Requirements above.

3.03 MANUAL MOTOR STARTERS

- A. Provide disconnecting means within sight of each motor controller and of each motor. Motor controller disconnecting means equipped with lock-out/tag-out padlock provisions do not require a disconnect switch at the controlled motor location. Locate disconnect means in view of and not inside of equipment, such that tools are not needed to remove covers to access the disconnecting means.
- B. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- C. See General Installation Requirements above.

3.04 SAFETY SWITCHES

- A. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- B. See General Installation Requirements above.

3.05 ENCLOSED CIRCUIT BREAKERS

- A. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- B. See General Installation Requirements above.

3.06 MOLDED CASE SWITCHES

- A. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- B. See General Installation Requirements above.

END OF SECTION

SECTION 26 51 00
LIGHTING

PART 1 - GENERAL**1.01 SUMMARY**

- A. Work Included:
 - 1. Luminaires
 - 2. LED Drivers
 - 3. Lamps
 - 4. Lighting Poles
- B. Provide wiring for complete and operating lighting system.

1.02 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. NECA 500 - Commercial Lighting.
 - 2. UL 8750 – Light Emitting Diode (LED) equipment for use in lighting products.

1.04 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Submit:
 - a. LED Luminaires: Electrical ratings, dimensions, mounting, material, clearances, terminations, wiring, connection diagram, LM-79 photometric data, LM-80 lumen depreciation data.
 - b. LED Drivers
 - c. Lamps
 - 2. Submittal Cutsheets: Highlight, circle or otherwise graphically indicate which option(s) are being selected for the products submitted. Cutsheets that are not edited to indicate which products and options are submitted for this project or that list only catalog numbers to identify submitted options are not acceptable.
 - 3. Specified manufacturers are approved to submit bid. However, inclusion does not relieve manufacturer from supplying product as described.
 - 4. Provide the following operating and maintenance instructions as required by Section 26 00 00, Electrical Basic Requirements:
 - a. Luminaires
 - b. LED Drivers
 - c. Lamps
 - d. Lighting Poles

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Provide luminaires acceptable to code authority for application and location installed.
 - 2. Comply with applicable ANSI standards.
 - 3. Comply with applicable NEMA standards.

4. Provide luminaires and lampholders that comply with UL standards and have been listed and labeled for location and use indicated by a testing agency acceptable by the AHJ (e.g., UL, ETL, and the like).
5. Comply with OESC as applicable to installation and construction of luminaires.
6. Comply with fallout and retention requirements of OSSC for diffusers, baffles, and louvers.
7. Provide LED luminaires from the same manufacturer and manufacturing LED source batch for similar applications (e.g., all LED downlights from a single manufacturer and batch, all linear LED products from single manufacturer and batch).

1.06 WARRANTY

- A. Warranty as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 1. LED Luminaire Manufacturer's Warranty: Not less than 5 years for luminaire based on date of substantial completion. Includes normal cost of labor to replace luminaire. Replacement luminaire will match physical dimensions, physical appearance, chromaticity, lumen output and photometric characteristics of original installed equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Luminaires:
 1. Reference description and manufacturers in Luminaire Schedule on Drawings.
 2. Or approved equivalent.
- B. LED Drivers:
 1. Indoor Drivers:
 - a. eldoLED Series
 - b. Advance/Philips
 - c. Osram Sylvania
 - d. Or approved equivalent.
 2. Outdoor Drivers:
 - a. Advance/Philips
 - b. Osram Sylvania
 - c. LG
 - d. Or approved equivalent.
- C. Lamps:
 1. LED (Light Emitting Diode) Lamps:
 - a. Nichia
 - b. Cree
 - c. Osram Sylvania
 - d. GE Lumination
 - e. Or approved equivalent.
 2. Unless specific manufacturer not shown on this list is indicated in the Luminaire Schedule.
 3. Special types as indicated in Luminaire Schedule.
 4. Or approved equivalent.
- D. Lighting Poles:
 1. Reference description and manufacturers in Luminaire Schedule on Drawings.
 2. Or approved equivalent.

2.02 LUMINAIRES

- A. Luminaires: Reference description and manufacturers in Luminaire Schedule on drawings.
- B. Where recessed luminaires are installed in cavities intended to be insulated, provide IC rated luminaires or other code approved installation.

- C. UL label luminaires installed under canopies, roof or open porches, and similar damp or wet locations, as suitable for damp or wet location.
- D. Suspended luminaires: Provide minimum 24-inch adjustability in aircraft cable length where used.
- E. Recessed Luminaires: Frame compatible with ceiling material installed at particular luminaire location. Provide proper factory trim and frame for luminaire to fit location and ceiling material. Verify with Architectural Reflected Ceiling Plan prior to submittals.
- F. Finishes:
 - 1. Manufacturer's standard finish (unless otherwise indicated) over corrosion resistant primer.
 - 2. Interior Light Reflecting Finishes: White or specular finish with not less than 85 percent reflectance.
 - 3. Exterior Finishes: As detailed in Luminaire Schedule or on drawings. Refer cases of uncertain applicability to Architect for resolution prior to release for fabrication.
- G. Light Transmitting Components:
 - 1. Plastic diffusers, molded or extruded of 100 percent virgin acrylic.
 - 2. Prismatic acrylic, extruded, flat diffusers, 0.125-inch overall thickness, unless otherwise noted.
- H. LED Luminaires:
 - 1. UL listing of luminaire includes drivers, transformers, enclosures, rated wire, communications devices and accessories needed for a complete and functional system.
 - 2. LM-79: Testing and measurement of absolute photometry, chromaticity (CCT) and luminaire power. Report provided by DOE certified independent testing laboratory. CCT as specified in Luminaire Schedule.
 - 3. Standards: ANSI C78.377, LM-79 and LM-82 compliant for performance characteristics, photometry, colorimetry, efficacy and thermal characteristics.
 - 4. LM-80 + TM-21: Testing and measurement, and statistical prediction of LED lamp life. Report provided by DOE certified independent testing laboratory.
 - 5. LEDs in one module/luminaire: Supplied from same batch/bin and fall within 3-step MacAdam Ellipse, or as described in Luminaire Schedule, whichever is the more stringent requirement.
 - 6. Provide luminaires with integral LED thermal management system (heat sinking).
 - 7. Luminaires to be equipped with an LED driver that accepts 120V through 277V, 50Hz to 60Hz (universal). Component-to-component wiring within the luminaire will carry no more than 80 percent of rated current and be listed by UL for use at 600VAC at 302 degrees F/150 degrees C or higher. Plug disconnects to be listed by UL for use at 600VAC, 15A or higher.
 - 8. Provide luminaires with individual LED arrays/modules and drivers that are accessible and replaceable from exposed side of the luminaire.

2.03 LED DRIVERS

- A. General:
 - 1. Performance: Meet dimming range called out in Luminaire Schedule, free from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
 - 2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
 - 3. Minimum efficiency of 85 percent, power factor greater than or equal to 0.90, compliance with reduction of hazardous substances (RoHS). Rated for operating temperature range of area in which driver is installed.
 - 4. Limit inrush current to minimize breaker tripping.
 - a. Base specification: NEMA 410 standard for inrush current for electronic drivers.

- b. Preferred Specification: Meet or exceed 30 milliamp-squared-seconds at 277VAC for up to 50 watts of load and 75 amps at 240 microseconds at 277VAC for 100 watts of load.
 5. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
 6. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
 7. Total Harmonic Distortion less than 20 percent percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD at no point in the dimming curve allows imbalance current to exceed full output THD.
 8. Support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
 - a. Adjustment of forward LED voltage, supporting 3V through 55V.
 - b. Adjustment of LED current from 150mA to 1.4A at the 100 percent control input point in increments of 1mA.
 - c. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
 9. Operate for a (+/- 10 percent) supply voltage of 120V through 277VAC at 60Hz.
 10. UL Recognized under the component program and modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
 11. Ability to provide no light output when the analog control signal drops below 0.3 V, or the DALI/DMX digital signal calls for light to be extinguished and consume 0.5 watts or less in this standby. Control dead band between 0.3V and 0.65V included to allow for voltage variation of incoming signal without causing noticeable variation in luminaire to luminaire output.
- B. Light Quality:**
1. Over the entire range of available drive currents, driver to provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0 percent relative light output, or 100 percent to 1 percent light output and step to 0 percent where indicated. Driver to respond similarly when raising from 0 percent to 100 percent.
 - a. Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.
 2. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels.
 3. Drivers to track evenly across multiple luminaires at all light levels, and must have an input signal to output light level that allows smooth adjustment over the entire dimming range.
 4. Driver and luminaire electronics to deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100 percent to 0.1 percent luminaire will have:
 - a. LED dimming driver to provide continuous step-free, flicker free dimming similar to incandescent source.
 - b. Base specification: Based on IEEE PAR1789, minimum output frequency should be greater than 1250 Hz.
 - c. Preferred specification: Flicker index to be equal to incandescent, less than 1 percent at all frequencies below 1000 Hz.
- C. Control Input:**
1. Provide control protocol to match lighting control system specified for use with luminaire.
 2. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers:
 - a. Meet IEC 60929 Annex E for General White Lighting LED drivers.
 - b. Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
 - c. Meet ESTA E1.3 for RGBW LED drivers.

2.04 LAMPS

- A. Provide lamps for luminaires.
- B. Provide lamp catalogued for specified luminaire type.
- C. Incandescent Lamps: Not allowed unless noted in Luminaire Schedule.
- D. LED (Light Emitting Diode):
 - 1. LED manufacturer will include, but not be limited to, light source, luminaire, power supply and control interface with added components as needed for complete and functioning system.
 - a. Comply with ANSI chromaticity standard for classifications of color temperature. See Luminaire Schedule for specified LED lamp color and color temperature. UL or ETL listed and labeled.
 - b. Luminaire testing per IESNA LM-79 and LM-80 procedures.
 - c. Lamp life for white LEDs: 50,000 plus hours with lamp failure occurring when LED produces 70 percent of initial rated lumens.
 - d. Lamp life for color LEDs: 30,000 plus hours with lamp failure occurring when LED produces 50 percent of its initial rated lumens.
 - e. LED Drivers: Reverse polarity protection, open circuit protection, require no minimum load. Minimum 80 percent efficiency. Class A noise rating.
 - f. Dimming: LED system capable of full and continuous dimming.
 - g. Correlated Color Temperature (CCT): See Luminaire Schedule for selection of color temperature for each luminaire. Ranges given below reflect maximum allowable tolerances for color temperature range for each nominal CCT.
 - 1) Nominal CCT:
 - (a) 2700 K (2725 ± 145)
 - (b) 3000 K (3045 ± 175)
 - (c) 3500 K (3465 ± 245)
 - (d) 4000 K (3985 ± 275)
 - h. Color Rendering Index (CRI) to be greater than or equal to 80.
 - 2. Special types as indicated in Luminaire Schedule.

2.05 LIGHTING POLES

- A. Provide direct buried exterior light poles with concrete bases or direct buried which are structurally supportive of pole under design loading.
- B. Provide exterior poles clean and scratch free with base bolt covers to match pole and luminaire finish.
- C. Provide poles and pole bases rated for a minimum of 100 MPH, unless otherwise noted. Wind EPA loading for quantity and type of luminaire it supports with a 1.3 gust factor.
- D. Provide poles with gasketed handholes, stainless steel tamper resistant hardware, anchor bolts and ground lugs.
- E. Description:
 - 1. Material: Steel, Aluminum, Treated wood, or Concrete.
 - 2. Shape: Tapered round, Round, or Square.
 - 3. Finish: Galvanized, Primed for field painting, or Anodized.
 - 4. Base: Embedded, Anchor, or Transformer.
 - 5. Accessories: Slipfitter and Mast Arms.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install per manufacturer's written installation instructions and requirements.
- B. Install luminaires securely, in neat and workmanlike manner.

- C. Install luminaires of types indicated where shown and at indicated heights in accordance with manufacturer's written instructions and with recognized industry practices to ensure that luminaires comply with requirements and serve intended purposes.
- D. Wiring:
 - 1. Recessed luminaires to be installed using flexible metallic conduit with luminaire conductors spliced to branch circuit conductors in nearby accessible junction box over ceiling. Junction box fastened to building structural member within 6-feet of luminaire.
 - 2. Luminaires for lift out and removal from ceiling pattern without disconnecting conductors or defacing ceiling materials.
 - 3. Flexible connections where permitted to exposed luminaires; neat and straight, without excess slack, attached to support device.
 - 4. Install junction box, flexible conduit and high temperature insulated conductors for through wiring of recessed luminaires.
- E. Relamp luminaires which have failed lamps at substantial completion.
- F. Replace LED drivers deemed as excessively noisy by Architect, Engineer, or Owner.
- G. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
- H. Support luminaires larger than 2- by 4-foot size independent of ceiling framing.
- I. Locate recessed ceiling luminaires as indicated on architectural reflected ceiling plan.
- J. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- K. Exposed Grid Ceilings:
 - 1. Support surface mounted luminaires in grid ceiling directly from building structure.
 - 2. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires.
 - 3. Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.
- L. Install recessed luminaires to permit removal from below.
- M. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- N. Install clips to secure recessed grid-supported luminaires in place.
- O. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Architectural Drawings.
- P. Install accessories furnished with each luminaire.
- Q. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- R. Bond products and metal accessories to branch circuit equipment grounding conductor.
- S. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.
- T. Where manufactured wiring assemblies are used, ensure that wiring assembly manufacturer sends components to appropriate luminaire manufacturer for respective installation of proper components.
- U. Coordination:
 - 1. Coordination of Conditions: Coordinate ceiling construction, recessing depth and other construction details prior to ordering luminaires for shipment. Refer cases of uncertain applicability to Architect for resolution prior to release of luminaires for shipment. Where luminaires supplied do not match ceiling construction, replace luminaires at no cost to Owner.

2. Electrical drawings are schematic, identifying quantity and type of luminaires used and their approximate location, but are not to be used for dimensional purposes. Reference architectural drawings for exact locations, including mounting heights.
 3. Provide lighting indicated on drawings with luminaire of the type designated and appropriate for location.
 4. Provide LED luminaires with driver compatible to lighting control system as shown in drawings and as specified.
 5. Where remote drivers are required, ensure adequate accessibility to driver. Upsize conductors between luminaire and driver to accommodate voltage drop.
- V. Field Quality Control:
1. Perform field inspection in accordance with Division 01, General Requirements.
 2. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- W. Cleaning:
1. Clean electrical parts to remove conductive and deleterious materials.
 2. Remove dirt and debris from enclosures.
 3. Clean paint splatters, dirt, dust, fingerprints, and debris from luminaires.
 4. Clean photometric control surfaces as recommended by manufacturer.
 5. Clean finishes and touch up damaged finishes per by manufacturer's instructions.
- X. Demonstrate luminaire operation for minimum of two hours.

3.02 LUMINAIRES

- A. Install per manufacturer's written installation instructions and requirements.
- B. Align, mount and level luminaires uniformly. Use ball hangers for suspended stem mounted luminaires.
- C. Avoid interference with and provide clearance from equipment. Where indicated locations for luminaires conflict with locations for equipment, change locations for luminaire by minimum distance necessary as directed by Architect.
- D. Suspended Luminaires: Mounting heights indicate clearances between bottom of luminaire and finished floors.
- E. Emergency Egress Luminaires: Provide unswitched circuit for battery charging and autotransfer circuiting for exit signs and luminaires with integral batteries. Where test switch cannot be integral to luminaire, mount remote test switch flush-to-ceiling and adjacent to egress luminaire.
- F. Interior Luminaire Supports:
1. Support Luminaires: Anchor supports to structural slab or to structural members within a partition, or above a suspended ceiling.
 2. Maintain luminaire positions after cleaning and relamping.
 3. Support luminaires without causing ceiling or partition to deflect.
 4. Provide mounting supports for recessed and pendant mounted luminaires as required by IBC.
- G. Adjusting:
1. Aim and adjust luminaires as indicated.
 2. Focus and adjust floodlights, spotlights and other adjustable luminaires, with Architect, at such time of day or night as required.
 3. Align luminaires that are not straight and parallel/perpendicular to structure.
 4. Position exit sign directional arrows as indicated.

3.03 LED DRIVERS

- A. Install lamps per manufacturer's installation instructions and requirements.
- B. Where driver is remote mounted, size wiring based on type of driver, driver distance from luminaire, and voltage/power level, and manufacturer's installation instructions.

- C. Protect 0-10V input from line voltage mis-connection, and so it will be immune and the output unresponsive to induced AC voltage on the control leads.

3.04 LIGHTING POLES

- A. Install lighting poles per manufacturer's installation instructions and requirements.
- B. Exterior Luminaire Supports:
 - 1. Provide concrete bases for pole-mounted lighting units and bollard lights at locations shown on site plan drawing(s). Provide concrete bases as shown on drawings or as recommended by manufacturer if not shown on drawings. Minimum base height above grade in automobile areas is 30-inches. Install luminaire poles plumb.
 - 2. Install pole concrete bases in undisturbed or compacted soil. Where soil is disturbed provide backfill and compaction per Division 31, Earthwork requirements.

END OF SECTION