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SECTION 260500 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the drawings and/or in these specifications, including all labor, services, permits, fees, utility charges, and incidentals necessary and required to perform and complete the electrical work described in this Division. Apply for all permits early in the project to avoid problems due to code revisions.
- B. See the contract conditions (general and supplementary) and Division 1 for requirements concerning this Division including, but not limited to, submittals, shop drawings, substitution requests, change orders, maintenance manuals, record drawings, coordination, permits, record documents and guarantees.
- C. Division 26 Contractor shall be responsible for all work indicated by divisions 26, 27, 28, and the electrical portions of 33 within the drawings and specifications. Any work indicated by Division 16 shall be provided and installed by the Division 26 Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

- A. Mechanical equipment motors to be furnished under another Division but connected under this Division. Starters to be mounted and connected by this Division, but furnished by another Division unless otherwise noted on the electrical drawings. Verify and coordinate all equipment locations and electrical characteristics with other trades involved in the work. Coordination shall be done prior to rough-in or ordering equipment.
- B. Control wiring, both line and low voltage, for mechanical equipment beyond provisions shown on the Electrical Drawings shall be performed under another Division of the work.

1.4 QUALITY ASSURANCE:

- A. Do all work in accordance with regulations and requirements of the National Electrical Code, state and local codes and amendments, National Fire Codes, and all other applicable Codes.

1.5 PROJECT CONDITIONS:

- A. The Contractor shall inspect the job site prior to bidding and familiarize himself with existing conditions which will affect the work. Prior to start of work, obtain "As built", "Record", or other Drawings showing existing underground utilities.

- B. Electrical drawings are diagrammatic indicating approximate location of outlets, lighting fixtures, electrical equipment, etc. Consult the Architectural, Structural, and Mechanical Drawings to avoid conflicts with equipment, structural members, etc. When required make all deviations from Drawings to make the work conform to the building as constructed, and to related work of others. Minor relocations ordered prior to installation may be made without added cost to Owner.
- C. Call to the attention of the Engineer/Architect any error, omission, conflict or discrepancy in Drawings and/or Specifications. Do not proceed with any questionable items of work until clarification of same has been made.
- D. Under no conditions are beams, girders, footings or columns to be cut for electrical items unless so shown on Drawings or written approval obtained from the Engineer/Architect.
- E. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Engineer/Architect prior to roughing-in if conflicts appear. Coordination of equipment to the available space and to the access routes through the construction shall be the Contractor's responsibility.

1.6 SHOP DRAWINGS:

- A. Prior to ordering equipment, and prior to Contractor's first application for payment, the Contractor shall, within 14 days after award of this work, submit complete shop drawings, electronic PDF copy with PDF index tabs, to the Architect, of materials and equipment he proposes to furnish. It is preferred that all sections be submitted at once, however, in the event that one or more sections need approvals quickly and others are not prepared yet, the Engineer will agree to review the individual section submittals needing immediate approval. However, each individual submittal section must be complete and remaining submittals that are not a rush shall be submitted all in one package as quickly as possible. Submitting individual sections over many weeks/months will not be tolerated.
- B. List shall bear Contractor's stamp, signature or other means to show that he has inspected same and certified that submitted material is correct in regard to quantity, size, dimension, quality and is coordinated with the Contract Documents.
- C. See individual sections within this Division for products requiring submittal.
- D. Each shop drawing submittal shall be prepared by the manufacturer, and shall clearly show manufacturer's name, catalog numbers, pictures, details, layout, type, size, rating, style, and all options identified in a permanent fashion. Specific items or options shall be permanently marked on sheets containing more than one option – do not rely on the Engineer to mark options. Yellow highlight by itself will not be an acceptable means of marking as it may not copy well.
- E. Large equipment drawings such as panelboards, and similar large equipment shall include the size, weight, seismic rating, emissions data, elevation, and wiring diagrams in addition to the product data.

- F. Some sections of this Division may require shop drawings prepared on full size floor plans in AutoCAD or other CAD software. Where required, contact the Architect for the latest version of the electronic plans and match the size and scale of the construction drawings. Drawings delivered to the contractor from the Architect/Engineer may not include addenda changes. Contractor shall only use electronic plans for purposes of the construction on this job, and not for any other use or reuse. Add any required addenda items prior to finishing shop drawings and submittals.
- G. Provide complete materials (all materials) list at the beginning of each tabbed section showing "Submittal Number", "Specification Section", "Material Item", "Manufacturer's Name and Catalog Number", and all pertinent data.
- H. Provide samples where required in individual sections of this Division.
- I. Contractor agrees that Shop Drawing Submittals processed by the Engineer/Architect are not Change Orders; that the purpose of Shop Drawing Submittals by the Contractor is to demonstrate to the Engineer/Architect that the Contractor understands the design concept, that they demonstrate their understanding by indicating which equipment and material they intend to furnish and install and by detailing the fabrication and installation methods they intend to use.
- J. Contractor further agrees that if deviations, discrepancies or conflicts between Shop Drawings and Specifications are discovered either prior to or after Shop Drawing Submittals are processed by the Architect/Engineer, the design Drawings and Specifications shall control and shall be followed.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. All materials shall be new and bear manufacturer's name, model number, electrical characteristics and other identification. All equipment to be U.L. approved or listed by another testing agency approved by authorities having jurisdiction.
- B. Material and equipment shall be standard product of manufacturer regularly engaged in production of similar material for at least five years (unless specifically exempted) and shall be manufacturer's latest design.
- C. If the description of a product is in conflict with the product as specified in the catalog number, the description shall generally take precedence. Contact the Architect for clarification if this occurs.
- D. All equipment must be rated and certified for the appropriate seismic design category or seismic use group for the installed geographical location. For essential or life safety equipment, provide an additional seismic factor of 1.5.

2.2 DISCONNECTS:

- A. Safety and disconnect switches to be Heavy duty quick-make, quick-break, dual rated, lockable, and of such electrical characteristics as required for the load served. Switches to have defeatable cover interlock.
- B. Fuse clips shall accept Class R or Class L fuses if required. Motor rated toggle switches equal to Square D Class 2510, type F with thermal overloads may be used as motor disconnects in dry locations for fractional horsepower motors.
- C. Disconnect switches required by code shall be installed whether or not specifically shown on the Drawings.
- D. Disconnect switches for refrigeration equipment and multiple motor HVAC equipment shall be fusible type.
- E. Safety and disconnect switches (fuse, non-fuse or circuit-breaker type) to be of same manufacturer as switchgear and panelboards.

2.3 FUSES:

- A. Provide fuses as indicated on the drawings, sized per NEC, or as required by the equipment manufacturer, whichever provides maximum protection, for a fully operational system.
- B. All fuses shall be furnished of the same manufacturer.
- C. All fuses shall be installed by the electrical contractor at job-site and only when equipment is to be energized. Fuses shall not be installed during shipment.
- D. All fuses to be 200,000 AIC, Current-limiting, U.L., Time Delay, Dual-element Type as follows:

For motor circuits beyond the main and sub distribution boards, 600 volt and below:
Class RK-5 for 600 volt; FRS-R, FLS-R, & TRS-R
Class RK-5 for 250 volt; FRN-R, FLN-R, & TR-R

- E. SPARE PARTS: Provide 10% spare fuses, but not less than 3 of any one size and type.
- F. Approved Manufacturers, with catalog numbers listed in order: Bussman, Littelfuse, Ferraz Shawmut.
- G. If the electrical contractor wishes to furnish materials other than those specified, a written request, along with a complete short circuit and selective coordination study, shall be submitted to the engineer for evaluation at least 8 days prior to the bid date. If the engineer's evaluation indicates acceptance, a written addendum will be issued listing the other acceptable manufacturer.

2.4 BOXES:

- A. Outlet and junction boxes shall be sized in accordance with code requirements or as noted on the drawings.
- B. Unless otherwise specified or shown on the drawings, all outlet boxes for existing work shall be surface mounted style cast metal boxes. Gangable boxes are not acceptable. Outlet boxes shall not be smaller than 4" square and 1-1/2 inches in depth, unless otherwise noted. All outlet box covers, rings, or other fittings shall be galvanized. Boxes which are exposed to the weather shall be cast metal.
- C. Outlet boxes shall be designed for the intended use, and shall be installed flush with finish surface lines or not more than 1/8 inch back and shall be level and plumb. Long screws with spacers or shims for mounting devices are not acceptable. No combustible materials shall be exposed to wiring at outlets.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION METHODS:

- A. All items, articles, materials, and equipment specified under this Division shall be installed per the manufacturer's installation instructions. Where the manufacturer's instructions are in conflict with the directions provided elsewhere in this Contract, the Engineer shall be notified prior to beginning rough-in.
- B. Cutting or notching shall be kept to an absolute minimum and done when, and in a method approved by the Engineer/Architect. Patch and correct finished surfaces damaged by electrical work.
- C. Panels, cabinets and equipment shall be level and plumb and installed parallel with structural building lines. All equipment and enclosures shall fit neatly without gaps, openings, or distortions. Provide approved devices for closing all unused openings.
- D. Arrange circuit wiring as shown on the Drawings and do not alter or combine runs or homeruns without the specific approval of the Engineer/Architect. Feeder runs shall not be recombined or altered.
- E. Starters and similar noise producing devices shall not be placed on classroom or office walls which are common to occupied space. They are acceptable in the shop environment, separated from the shared classroom/office wall.
- F. Drivers, Ballasts, contactors, starters, VFD's, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

- G. In general, the mounting heights shall be as noted on the Drawings, or as listed below, the Architectural Interior Elevations and drawing notes taking precedence. Where no heights are indicated, request clarification from the Engineer/Architect. Consult the Architectural, Mechanical and Structural drawings to avoid conflicts prior to roughing-in and for exact locations. All dimensions are to the top of the back box or device whichever is higher. Lighting dimensions are to the bottom of suspended fixtures and center of wall mounted fixtures unless otherwise noted.

Light Switches	48 inches to center
Convenience Receptacles	18 to 42 inches to center as directed by owner
Receptacles and Outlets Over Counters	10 inches above counter or 5 inches above Backsplash to top, whichever is greater.
Panelboard	72 inches to top
Disconnects and Motor Controllers	72 inches to top
Fire Alarm Signals	96 inches to top (but at least 6" below ceiling)
Fire Call Stations	48 inches center

- H. Where raceways penetrate floors, ceilings, ducts, chases, and fire walls, provide fire stopping to maintain integrity of the fire assembly. Firestopping method shall be approved by the Code Authority having jurisdiction.
- I. All materials and equipment installed under this work shall be properly and adequately supported from the building structure except where ceiling construction or other provisions are specifically designed to support them. Support systems shall provide a safety factor of four. This shall apply to chains, hangers, anchors, clamps, screws, structural iron, and all other hardware and appurtenances associated with the support system.
- J. Maintain the following minimum separations from voice and data cables. Power conduit - 12", transformers and motors - 40", LED and fluorescent lighting - 12".

3.2 LOW VOLTAGE WIRING METHODS:

- A. Unless stated otherwise in these specifications, or on the drawings, raceways for low voltage wiring of Paging, Intercom, CCTV Cabling, Computer, and Telephone systems utilizing N.E.C. class II current limitation methods will be required in entire shop area where conductors might be exposed to physical damage. Provide Conduit homeruns complete for all low voltage systems. Plenum cabling will not be acceptable.
- B. Conduits shall be concealed in all finished spaces and shall be run parallel to structural lines and supported at minimum 10' intervals from structure.
- C. All low voltage cable must be suitable for the conditions in which it will be used. Prior to purchasing or installing any cable, confirm the environment cable will be installed. Where partial conduits are extended and other side is plenum, entire installation shall have plenum rated cable.

3.3 LABELING:

- A. Clearly and properly label the complete electrical system to indicate the loads served or the function of each item of equipment provided under this work.
- B. Permanent Engraved nameplates: shall be 1/16 inch thick, laminated three-ply plastic, center-ply white, outer-ply black (for normal power) or red (for emergency power) or orange (for UPS power) "Lamicoid" or equal. Letters shall be formed by engraving outer colored ply, exposing white center-ply, and shall be a minimum of 5/8 inch high. Nameplates shall be secured with screws or pop rivets.
- C. Provide permanent engraved nameplates for the equipment listed below as well as all other similar equipment; refer to each section for specific labeling requirements:
 - 1. Existing breakers at Switchboards
 - 2. Panelboards
 - 3. Motor Controllers, Variable Frequency Drives (VFD), Safety Disconnects
 - 4. Electrical Contactors and Relays
 - 5. Other similar electrical devices and equipment
- D. Self-Adhesive Labels: shall have self-adhesive "P-Touch" or equivalent sticky backs, black lettering with a clear (see through) background.
- E. Provide self-adhesive labels for the devices and equipment listed below as well as all other similar equipment; each label shall list the applicable circuit number feeding the device and devices fed from Emergency or UPS power shall also list "EMERGENCY" as applicable next to the circuit number (for example, a receptacle fed from circuit 2 in panel 1P1 would read "1P1-2" on the label):
 - 1. Thermal Switches and Manual Starters
 - 2. Power outlet receptacles
 - 3. Light Switches
 - 4. Fire alarm initiation devices (smoke detectors, heat detectors, pull stations, etc.)
 - 5. Fire alarm notification devices (horn/strobes, etc.)
- F. Provide neat and clearly legible handwritten labeling using a permanent "Sharpie" or equivalent chisel tip black marker for all junction boxes containing power and fire alarm wiring. Label each junction box with the applicable circuit number(s) for the cables contained within each junction box in a location and large enough to be clearly visible from the floor.
- G. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes.

3.4 SAFETY:

- A. The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the contractor to perform the work.

3.5 DEMOLITION:

- A. It is the intent of these specifications to require the contractor to make all necessary adjustments to the electrical system, required to meet code, and accommodate installation of the new and remodeled work.
- B. Remove all existing fixtures, clocks, switches, receptacles, raceways, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless specifically shown as retained or relocated on the drawings. If existing walls, ceiling, floors, etc. are moved, extend existing devices, fixtures, and circuiting to the new location.
- C. Disconnect all existing mechanical equipment scheduled for removal or relocation. See mechanical drawings for scope of work. Remove abandoned raceways and cables. Relabel panels and to reflect changes.
- 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, new conduit and wire shall be provided to bypass the abandoned outlets. If existing conduits pass through or are mounted on partitions or ceilings which are being removed or remodeled, new conduit and wire shall be provided to route around the ceiling or wall and maintain service to the existing load.
- E. Locations of items shown on the drawings as existing are partially based on as-built and other drawings which may contain errors. The Contractor shall verify the correctness of the information shown prior to bidding and provide such labor and material as is necessary to accomplish the intent of the contract documents. The plans may show some demolition conditions, but are not intended to show all of them.
- F. All materials accumulated during the demolition process are the Owners property and shall be removed from the job site and delivered to an Owner storage facility as directed by the Owner. If owner does not wish to salvage materials, contractor shall remove from jobsite and dispose, or recycle materials at contractor's discretion, in a lawful manner.
- G. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes.
- I. Demolish and dispose of hazardous materials in a lawful manner, such as PCB containing transformers or ballasts, mercury containing lamps, or materials containing lead. All costs for proper disposal shall be paid by the contractor unless specified elsewhere in the general conditions.

3.6 POWER INTERRUPTIONS:

- A. Keep outages to occupied areas to a minimum and prearrange all outages with the Owner's representative and utilities involved. Requests for outages shall state the specific dates and hours and the maximum durations, with the outages kept to these specified times. When power interruptions will last longer than 5 minutes and cover more than 10% of the building, or affect public areas, they shall be performed after school hours or on weekends.
- B. Contractor shall coordinate with the Owner so that work can be scheduled not to interrupt operations, normal activities, building access, etc. Coordinate work with other crafts for proper scheduling.
- C. No circuits shall be turned off without prior approval from owner. Coordinate with the Owner any interruptions which affect the operation of the remaining portions of the facility.
- D. This contractor will be liable for any damages resulting from unscheduled outages or for those not confined to the preapproved times. Include all costs for overtime labor as necessary to maintain electrical services in the initial bid proposal. Temporary wiring and facilities, if used, shall be removed and the site left clean before final acceptance. Requests for outages must be submitted at least (5) days prior to intended shutdown time.
- E. Include in bid cost of minimum temporary power for Fire Alarm System, Security, Telephone/Data equipment and any other equipment designated by Owner, during time when primary building power has been interrupted.

3.7 GROUNDING:

- A. Ground all electric equipment, raceways and enclosures in accordance with code rules and established safety practices.
- B. Install grounding conductors in approved metallic raceways unless specifically shown or specified otherwise. Bond at each end and at all intervening boxes and enclosures between the service equipment and grounding electrode.
- C. No. 8 and smaller grounding conductors shall have green insulation. No. 6 and larger shall be marked with green colored tape at each end and at every box, panel, switchboard, or point where conductor is accessible.

3.8 EQUIPMENT CONNECTIONS:

- A. The location and method for connecting to each item of equipment shall be verified prior to roughing-in. The voltage and phase of each item of equipment shall be checked before connecting. Motor rotations shall be made in the proper direction
- B. Conduit, wire and circuit breaker sizes for mechanical, and similar equipment are based on the equipment ratings of one manufacturer. The equipment actually furnished may have entirely different electrical characteristics. Conduit, wire, circuit breakers, disconnects, etc. shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination rests with the Contractor.

3.9 SEISMIC BRACING:

- A. Furnish and install all seismic bracing of equipment, feeders, lighting fixtures, and other electrical items in accordance with prevailing codes. Refer to ASCE 7-10, section 13.3 and 13.6 for calculation methods. Provide and submit the required designs, calculations, certifications, and stamped drawings to the authority having jurisdiction and obtain their approval prior to installation or fabrication.
- B. Where conduit, or conduit racks are attached to structures where they cross a seismic isolation interface, the electrical components shall be designed to accommodate the seismic relative displacement.

3.10 PAINTING:

- A. All electrical equipment and conduit exposed in finished areas and on exterior walls are to be painted to match surrounding surfaces.
- B. Contractor shall coordinate the timing of painting requirements.
- C. Refer to Architectural specifications for methods and materials.

3.11 PROJECT RECORD DOCUMENTS:

- A. Maintenance of Documents:
 - 1. Maintain at Jobsite, One Record Copy of: Contract Drawings, Specifications, Addenda, Reviewed Shop Drawings, Change Orders, Other Modifications to Contract and Field Test Records.
 - 2. Keep apart from documents used for construction.
 - 3. Keep documents available at all times for inspection by Architect.
- B. Recording:
 - 1. Label each document "PROJECT RECORD."
 - 2. Keep record documents current. Do not permanently conceal any work until required information has been recorded.
 - 3. Contract Drawings, legibly mark to record actual construction; including but not limited to the following:
 - a. Depths of various elements; locations of underground items, with dimensions to building walls and corners; changes of dimensions and details; changes made by Addendum, Field Orders or Change Order.
 - b. Specifications and Addenda; legibly mark each Section to record changes made by Addendum, Field Order or Change Order.

C. As-Built Submittals:

1. At completion of project, transfer changes, addenda items, variations from drawings, exact routes of all feeders and service conduits, and locations of stubbed conduits to clean new prints and specifications which will be supplied by the Architect and deliver to the Architect as "As-reported Record" drawings. Include dimensions to all buried or concealed conduits to permanent structures.

D. Operation and Maintenance Manuals

1. At completion of project, prepare Operation and Maintenance Manuals with operation and Maintenance Data, contractors warranties, and copies of approved electrical permits. Include corrected copies of original submittals and shop drawings.
2. See Division 1 for additional requirements.

3.12 WARRANTIES:

- A. Provide a minimum 1 year warranty on all electrical equipment, devices, labor, and work by Division 26 whether specified or not.
- B. Provide warranties greater than 1 year as specified in other sections where stated. The warranty requirement most stringent shall be used where conflicts arise.
- C. The systems listed below require warranties exceeding the minimum warranty:
 1. Lighting; 5 years for Drivers and ballasts refer to Section – 26 51 00
 2. Fire Alarm Systems; 2 years refer to Section – 28 31 00
- D. Provide copies of all warranties to the owner upon completion of the project.

3.13 COMPLETION:

- A. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of faults, shorts or unintentional grounds. Demonstrate system in the presence of the Architect, the Owner or their representative when requested.

3.14 FINAL OBSERVATION:

- A. Contractor shall submit written certification that:
 1. Contract Documents have been reviewed.
 2. Contractor has inspected Project for compliance with Contract Documents.
 3. Work has been completed in accordance with Contract Documents.

4. Equipment and Systems have been tested and are operational.
 5. Project is completed and ready for final inspection.
- B. Engineer/Architect will make final inspection as soon as possible after receipt of Certification.
- C. Should Engineer/Architect consider that work is finally complete in accordance with Contract Document requirements, Contractor shall make Contract Closeout submittals.
- D. Should Engineer/Architect consider that work is not finally complete:
1. He will so notify Contractor, stating reasons.
 2. Contractor shall take immediate steps to remedy deficiencies, and send second written notice to Engineer/Architect certifying that work is complete.
 3. Engineer/Architect will re-inspect work.
- E. The Engineer/Architect will make two final inspections. The first will determine deficiencies and errors in the work and the second will determine whether or not the noted deficiencies and errors have been satisfactorily corrected.
- F. If additional inspections are required because of the Contractor's failure to complete the deficiencies and errors prior to the second inspection, costs for the successive inspections will be back-charged to the Contractor by the Owner, who, in turn, will reimburse the Engineer/Architect. Charges will be based as follows:
1. Engineer/Architect time at current billing rates.
 2. Travel time, and all other expenses incurred in making inspections.
- G. Contractor to provide one (1) journeyman, tools, meters, instruments and other test equipment required by Engineer/Architect. Contractor to remove and replace trims, covers, fixtures, etc., for Engineer/Architect to review and test materials, systems, methods and workmanship. (Example: Removing switchboard and panel covers to take voltage/amp readings, review connections and wire size, etc.)

END OF SECTION 260500

SECTION 260519 – WIRES & CABLES (600V)

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all wires and cables as herein specified and shown on the associated drawings for service conductors, feeder conductors and branch circuit conductors.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

- A. Basic Material & Methods – Section 26 05 00.
- B. Raceways – Section 26 05 33.

1.3 QUALITY ASSURANCE:

- A. All wire and cable shall meet or exceed the following standards:
 - 1. ASTM-B series specifications
 - 2. ICEA S-61-402/NEMA WC 5 - Thermoplastic insulated cables 0-2000 volt
 - 3. UL Standard 62 and 83 – Thermoplastic insulated cable
 - 4. UL VW-1 Flame Test for sizes #12 through #1
 - 5. National Electric Code (NFPA 70) – Latest edition
- B. Manufacturer's shall be engaged in the manufacturing of industry accepted quality wires and cables for a period of no less than 5 years for all types and sizes required.

1.4 SUBMITTALS:

- A. None required.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Provide products of Southwire, Houston Wire, Rome Cable, or similar manufacturer located within the continental North American market. Cables made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.
- B. Substitutions: Equivalent manufacturers are allowed at contractors option, no submittals or prior approvals are necessary if cable meets specifications.

2.2 MATERIALS:

- A. Application: For use in general wiring applications for lighting and power in ducts, conduits, wireways and other approved raceways with a maximum conductor temperature of 90 degrees C in dry locations and 75 degrees C in wet locations.
- B. Provide wires and cables that are chemical, gasoline, and oil resistant. Provide wires and cables that are sunlight resistant.
- C. Minimum conductor size shall be No. 12 AWG unless otherwise noted.
- D. Where adverse conductor exposure exists, code approved insulation suitable for the conditions encountered shall be used unless shown otherwise on the Drawings.
- E. Wire and cable shall be new, shall have grade of insulation, voltage and manufacturer's name permanently marked on outer covering at regular intervals and shall be delivered in complete coils or reels with identifying size and insulation tags.

2.3 COPPER CONDUCTORS:

- A. For No. 10 AWG and smaller provide solid conductors or soft drawn stranded copper conductors with type THHN/THWN insulation.
- B. For No. 8 AWG and larger provide soft drawn stranded, Class B stranded copper conductors with type THHN/THWN insulation.

2.4 ALUMINUM AND/OR METAL CLAD (MC) CABLING OPTIONS:

- A. Aluminum and MC Cabling not acceptable – Provide copper only conductors.

2.5 COLOR CODE:

- A. All wires shall be fully colored in sizes 12 through 6 AWG, and color banded at each end with colored tape at all terminations, panels, equipment, junction boxes, and pull boxes for sizes 4 AWG and larger.
- B. Color Code throughout the project shall be:
 - 1. 480Y/277V System
 - Phase A Brown
 - Phase B Orange
 - Phase C Yellow
 - Neutral Grey
 - Neutral A (dedicated) Grey w/brown stripe #12 & #10
 - Neutral B (dedicated) Grey w/orange stripe #12 & #10
 - Neutral C (dedicated) Grey w/yellow stripe #12 & #10
 - Equipment Ground Green

2.	208Y/120V System	
	Phase A	Black
	Phase B	Red
	Phase C	Blue
	Neutral	White
	Neutral A (dedicated)	White w/black stripe #12 & #10
	Neutral B (dedicated)	White w/red stripe #12 & #10
	Neutral C (dedicated)	White w/blue stripe #12 & #10
	Equipment Ground	Green
	Isolated Ground	Green w/yellow stripe #12 & #10 Green and Yellow bands #8 and up

- C. Provide a permanent, plastic engraved label on the inside of each branch-circuit panelboard throughout the project identifying the Color Code used throughout the project. Refer to NEC 200.6 (D).

2.6 SPLICES AND TERMINATIONS:

- A. Splices shall utilize Scotch "Hyflex" or "Ideal" wing nut connector installed properly. Crimp on splices designed to be used without wire stripping are not acceptable.
- B. Splices for No. 8 and larger wires shall be made with mechanically applied pressure type connectors.
- C. All taped joints shall be with "Scotch 33+" or equal, applied in half-lap layers without stretching to deform.
- D. Where splice box is subject to rain, weather, or moisture, provide "Rain Tight" termination device.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Inspect exposed cables for physical damage and remove as length allows.
- B. Utilize pulling compound on long pulls. Ensure that cable reels and pulling apparatus are firmly secured prior to pulling. Use pulling attachments and materials including approved swivel connections, pulling eyes, and/or friction tape as applicable. Carefully follow all applicable safety requirements when pulling cables.
- C. Do not exceed manufacturers recommendations for maximum allowable tension, or side wall pressure. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.

- D. Do not exceed manufacturers recommendations for minimum allowable bending radius. For training of cables, minimum bend radius to inner surfaces of cable shall be 12 times cable diameter. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.
- E. Provide dedicated neutrals on all branch power receptacle circuits of 120/208 volt.

3.2 BRANCH CIRCUIT GROUNDED CONDUCTOR (NEUTRAL) WIRING METHODS:

- A. Dedicated (separate) neutral wiring methods
 - 1. Provide dedicated neutral wiring for the following system(s):
 - a. Lighting
 - b. Receptacles
 - c. Other than lighting and receptacle branch circuits
 - 2. Provide dedicated (separate) neutral for each branch circuit; shared/common neutral wiring is not allowed.
 - 3. For dedicated neutral branch wiring, there shall be no more than six (6) current carrying conductors allowed within a single raceway unless specifically allowed otherwise in the drawings. All neutral conductors shall be considered current carrying. Provide all required wire size increases to account for the applicable NEC wire ampacity deratings.
 - 4. Provide dedicated neutral cables with colored stripe as required in wire color coding section for identification.

3.3 PARALLELED CONDUCTORS:

- A. Under no condition shall conductors less than #1/0 AWG copper be run in parallel. Where paralleled runs are used, the contractor must cut to exact length on each phase leg. Where parallel conductors are run in parallel conduits, each conduit shall carry all phase legs as well as neutral, equipment ground, and/or isolated ground conductor as applicable.
- B. Size parallel ground conductors as per NEC 250.

3.4 SPLICES AND TERMINATIONS:

- A. Splices are to be made up complete promptly after wire installation.
- B. Single wire pigtails shall be provided for fixture and device connections. Wirenuts may be used for fixture wire connections to single wire circuit conductor pigtails.

- C. Install wing nut connector properly, according to manufacturers written instructions. Crimp on splices designed to be used without wire stripping are not acceptable.
- D. Torque bolted connections to manufacturer's recommendations. Torque both ends of the cable, or parallel cables to the same Torque level.
- E. Insulation shall be removed with a stripping tool designed specifically for that purpose. A pocket knife is not an acceptable tool. All conductors shall be left nick-free.
- F. Thermoplastic insulated wire and cable shall not be installed or handled in temperatures below +14 degrees F (-10 C). Cross-linked polyethylene insulated wire and cable may be installed to -40 degrees F (-40 C).

3.5 LABELING:

- A. Feeders – Provide an engraved laminated 3-ply plastic “Lamicoid” or equal label with feeder name attached with a nylon wire tie to the feeder at each entry and exit from pullboxes, wireways and any other similar locations.
- B. Branch Circuits – Clearly mark and identify the circuit number(s) at each junction box and similar location with a permanent black marker or equivalent that is clearly visible. For concealed junction boxes the marking shall be made on the outside coverplate; for exposed boxes or boxes with finished coverplates marking shall be made on the interior of the box where visible when removing the coverplate.

3.6 COMMISSIONING AND TESTING:

- A. Contractor shall provide for access and inspection of installed wires and cables by the Architect/Engineer, owner and commissioning agent.
- B. Document all tests and provide written copies in the O&M manuals.
- C. Perform continuity tests and resistance measurements through bolted connections to ensure correct cable connections.
- D. Perform insulation resistance test on all feeder conductors exceeding 100 amps, size #2 and larger. Values shall not be less than 50 megaohms.

END OF SECTION 260519

SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all grounding and bonding as code required and as herein specified and shown on the associated drawings.

1.2 APPLICATION:

- A. All grounding and bonding shall be by copper only connectors, copper cable and wire, and/or copper braids.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

- A. Basic Material & Methods – Section 26 05 00.
- B. Wires & Cables – Section 26 05 19.

1.4 QUALITY ASSURANCE:

- A. All installation of grounding and bonding conductors shall meet or exceed the following standards:
 - 1. ANSI/IEEE 142 for service ground electrode resistance (5 ohms).
 - 2. Ground electrode resistance at manholes and pad vaults (5 ohms)
 - 3. Ground electrode resistance at transformers (10 ohms)
 - 4. ASTM B 8 stranded conductors
 - 5. ICEA S-61-402/NEMA WC 5 - Thermoplastic insulated cables 0-2000 volt
 - 6. UL Standard 62 and 83 – Thermoplastic insulated cable
 - 4. UL VW-1 Flame Test for sizes #12 through #1
 - 7. National Electric Code (NFPA 70) – Latest edition
 - 8. UL listing is required
- B. Manufacturers shall be engaged in the manufacturing of industry accepted quality grounding connectors for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

- A. None required.

PART 2 - PRODUCTS

2.1 GROUNDING CONNECTORS AND GROUND RODS:

- A. ACCEPTABLE MANUFACTURERS: Subject to compliance with all requirements, provide products of one of the following manufacturers for grounding connectors:
 - a. Chance/Hubbell
 - b. Copperweld Corporation
 - c. Erico Inc., Electrical Products Group
 - d. Burndy Electrical
 - e. Kearney/Cooper Power Systems
 - f. O-Z/Gedney Co
 - g. Raco/Hubbell
 - h. Thomas & Betts Electrical
- B. Provide products of a quality manufacturer located within the continental North American market. Grounding connectors made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.
- C. Provide products that are listed and labeled by UL for all applications used, and for specific types, sizes and combinations of conductors and other items connected.
- D. For buried connections, provide crimp style connections or welded type connections. For accessible connections, provide bolted pressure-type, torque as per manufacturers recommendations.
- E. Substitutions: Equivalent manufacturers are allowed at contractor's option, no submittals or prior approvals are necessary if ground connectors and rods meet specifications.

2.2 CONDUCTORS:

- A. Provide copper or tinned-copper wire and cable insulated for 600 volt unless otherwise required by applicable code or authorities with jurisdiction.
- B. Provide minimum of #6 AWG copper stranded grounding electrode conductor for the portion of the conductor which is the sole connection to the ground rod grounding electrode. The minimum conductor size shall comply with NEC table 250.66.

- C. Provide No. 4 and/or No. 6 AWG stranded conductor for bonding conductors.
- D. Bonding Jumper: Provide copper tape, braided copper conductors, terminated with copper ferrules, 1-5/8 inches wide and 1/16 inch thick.

PART 3 - EXECUTION

3.1 GROUNDING INSTALLATION:

- A. Ground all electric equipment, raceways and enclosures in accordance with code rules and established safety practices.
- B. Install insulated equipment grounding conductors in all types of raceways for all power feeders and branch circuits
- C. Route grounding electrode conductors along the shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subject to strain, impact, or damage.
- D. Grounding electrode conductors and bonding jumper connections to grounding electrodes shall be accessible (unless allowed by NEC 250.68(A) exceptions) and provide a continuous effective grounding path.
- E. No. 8 and smaller grounding conductors shall have green insulation. No. 6 and larger shall be marked with green colored tape at each end and at every box, panel, switchboard, or point where conductor is accessible.
- F. For equipment subject to vibration, install bonding jumper so that vibration is not transmitted through the grounding connection.

3.2 CONNECTIONS

- A. For equipment grounding connections #10 and smaller, grounding conductors may be terminated with appropriate winged pressure type connectors (wirenuts). For #8 and larger, use pressure-type grounding lugs.
- B. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturers published torque-tightening values. If manufacturers data is not available, tighten according to UL468A.
- C. For compression type connections, use hydraulic compression tools and dies to provide the correct circumferential pressure for all connectors. Use only tools and dies as recommended by the connector manufacturer. Provide embossing die code or other standard method to make a visible, permanent indication that a connector has been adequately compressed onto the grounding conductor.

3.3 COMMISSIONING AND TESTING:

- A. Contractor shall provide a time for access and inspection of grounding system for the Architect/Engineer. Correct all defects and flaws found prior to testing.

- B. Demonstrate electrical continuity at selected connections to the architect/engineer using an electrical ohmmeter. Point to point resistance values shall not exceed 0.5 ohms. Provide additional bonding as necessary to ensure these resistance values are less than 0.5 ohms.

END OF SECTION 260526

SECTION 260533 - RACEWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all raceways, wireways, and associated fittings as herein specified and shown on the associated drawings.

1.2 APPLICATION:

- A. Electric metallic tubing (EMT), galvanized rigid conduit (GRC), intermediate metal conduit (IMC), and flexible metal conduit may be used. PVC and Electric Non-metallic Tubing (ENT) may not be used.
- B. GRC and IMC shall be used in locations subject to mechanical injury, for penetrations of building walls. GRC and IMC may be used: outside, where exposed to weather, in wet locations, in hazardous locations (as approved by code). Schedule 80 PVC may not be substituted for GRC and IMC.
- C. EMT may be used only in dry and protected locations. EMT may not be used: outside, where exposed to weather, in hazardous locations or where subject to mechanical injury.
- D. Flexible metal conduit (FMC) will be permitted only where flexibility is necessary. FMC may be used only where flexibility is necessary in dry protected locations, such as: connections to recessed light fixtures, work fished into existing concealed dry locations, stud or wood frame construction. Flexible metal conduit shall be used for connection to all equipment subject to movement or vibration such as motors. Length shall not exceed 6 feet unless fishing in existing construction.
- E. Liquid-Tight Flexible Metal Conduit (LFMC) shall substitute only in those locations where flexible metal conduit is required and additional moisture protection is desired or needed. LFMC may be used: for connections to motors or fixed equipment where subject to moisture or weather and subject to movement or vibration. Length shall not exceed 6 feet unless specified otherwise.
- F. Drawing notes requiring a specific type of raceway shall take precedence over the specifications.
- G. Surface Metal Raceways and/or wireways of appropriate size to contain all wires and devices shall be used where indicated. For device locations on existing masonry, or where switching boxes are installed at new ADA height, Surface Metal Raceway equal to Wiremold V500 or V700 series may be used with appropriate mating device box.
- H. Surface Plastic raceways (Wiremold) shall not be used as plastic raceways do not survive vandalism in a High School environment.
- I. Electrical wiring shall be in U.L. approved raceways and enclosures throughout.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

- A. Basic Material & Methods – Section 26 05 00.
- B. Wires and cables (600V) – Section 26 05 19.
- C. Seismic Restraint for Electrical – Section 26 05 48

1.4 QUALITY ASSURANCE:

- A. All installation of conduits and raceways shall meet or exceed the following standards:
 - 1. Rigid Metal Conduit (RMC): in accordance with ANSI C80.1.
 - 2. Electric Metallic Tubing (EMT): in accordance with ANSI C80.3.
 - 3. Seismic Bracing: ASCE 7-10, Section 13.6, latest edition
 - 4. National Electric Code (NFPA 70) – Latest edition
 - 5. UL listing is required
- B. Manufacturer's shall be engaged in the manufacturing of industry accepted quality raceway for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

- A. Conduit and conduit fitting product data submittals are not required.
- B. Submit seismic bracing calculations, bracing and anchoring products, and bracing designs for suspended conduits and conduit racks as a deferred submittal as required per section 26 05 48. Submittal shall be as early as possible in the contract and prior to installing suspended conduits and conduit racks. Installation shall comply with the deferred submittal including all components and anchors used.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Provide products of a quality manufacturer located within the continental North American market. Conduit and Raceways and Fittings made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.
- B. Substitutions: Equivalent manufacturers are allowed at contractor's option, no submittals or prior approvals are necessary if conduit and fittings meet specifications.

2.2 RACEWAYS:

- A. Galvanized Rigid Metal Conduit (GRC): Provide zinc-coated, hot-dipped galvanized, rigid metallic conduit in sizes indicated on the drawings. Provide RMC in $\frac{3}{4}$ inch minimum size.
- B. Intermediate Metal Conduit (IMC): Provide hot-dipped galvanized, intermediate metal conduit in sizes indicated on the drawings. Provide IMC in $\frac{3}{4}$ inch minimum size.
- C. Electric Metallic Tubing (EMT): Provide electric metal tubing in sizes indicated on the drawings.

Provide EMT in $\frac{3}{4}$ inch minimum size;

- D. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight, flexible metal conduit, constructed of single strip, flexible continuous, interlocked, and double-wrapped steel, galvanized inside and outside, coated with liquid-tight jacket of flexible Polyvinyl Chloride (PVC). Provide Liquid-Tight Flexible conduit in $\frac{3}{4}$ inch minimum size.
- E. Aluminum conduit is not acceptable.

2.3 FITTINGS:

- A. Provide listed fittings and connectors that are suitable for the application and the environment installed.
- B. EMT Connectors and couplings shall be steel, set screw type for interior application. EMT connectors and couplings where located outside in protected locations or where subject to damp environments shall use compression type connections.
- C. For EMT connections to panelboards and boxes that exceed one inch size, or where #4 or larger conductors are pulled, or for any size conduit where subject to vibration, provide with insulated throats on connectors or other identified fitting providing a smoothly rounded insulating surface integral to the fitting. Use insulated throat set-screw connectors for smaller conduit sizes up to one inch, and use O-Z/Gedney type SBT/SB insulated bushings or equal selected by the contractor for sizes 1-1/4 inch and larger.
- D. Aluminum fittings, Die-cast fittings or fittings made from pot metal shall not be allowed. Indenter type fittings are not acceptable.
- E. Plastic only bushings are not to be used on power conduits.
- F. GRC and IMC shall be coupled and terminated with threaded fittings. Provide fully-threaded, malleable steel fittings, rain-tight and concrete-tight as applicable. Provide double locknuts and metal bushings with insulated throat at all conduit terminations at boxes, panels, cabinets, switchboards, and stub-outs. Fittings of O-Z/Gedney type B or equal As selected by the contractor are acceptable for these applications.
- G. FMC and LFMC fittings shall be in accordance to industry standards.

- H. Sealing bushings are to be provided equal to O-Z/Gedney Type FSK, WSK or CSMI as required by application. Provide equal to O-Z/Gedney Type CSB for internal sealing bushings.
- I. Expansion fittings shall be equal to O-Z/Gedey AXDX.

2.4 SUPPORT AND SEISMIC BRACING COMPONENTS

- A. Provide C clamps, beam clamps, and other type clamps for direct installation on structural beams or wall structures.
- B. For suspended conduits, refer to section 26 05 48 for required deferred submittals and seismic bracing design requirements. Provide rigid support for all conduits, tie wire and systems that utilize wire as main vertical support are not allowed, wire may be used for horizontal and longitudinal bracing only if calculated and detailed in the contractors deferred submittal and approved by the shop drawing process.
- C. As necessary and as shown in deferred submittal for suspended conduits, provide the following components for vertical support and lateral/longitudinal seismic bracing:
 - 1. Strut: Unistrut (or equal) P1000 Metal Framing Channel
 - 2. Allthread: Stainless Steel, 3/8 minimum size
 - 3. Angles/Hinges: Bline B335-2 or Mason Industries SCB Swivel Anchor
 - 4. Expansion anchors: Hilti Kwik Bolt II (or equal) minimum 3/8 inch x 2-1/4 inch depth
 - 5. Hardware: Miscellaneous cap screw/spring nuts and other hardware required for a complete system.
 - 6. Other hardware as designed in the contractors deferred submittal per section 26 05 48.

2.5 BOXES

- A. Refer to section 26 05 00 for appropriate boxes.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Provide pull boxes where shown or required to limit the number of bends in any run to not more than three 90 degree bends. Use code gauge galvanized sheet steel boxes of code required size with removable covers, installed so that covers will be accessible after work is completed. Verify with the Engineer/Architect any locations in finished areas.
- B. Exposed raceways shall be parallel to structural lines and location must be approved by Architect/Engineer prior to installation.

- C. Do not place conduits within 1-1/2 inches of the upper flutes of roof decking.
- D. Maintain a minimum of 6 inches spacing from Hot water and/or steam lines, and 2 inches from Chilled Water and Culinary Water lines. Do not support conduit from other utility services.
- E. All conduit leaving building envelope (e.g. site lighting, roof mounted HVAC requirement, etc.) to be 0.75" minimum.
- F. Field bends and offsets shall be made without flattening, kinking, rippling or destroying the smooth internal bore or surface of the conduit and to not less than NEC minimum radius. Conduit that shows signs of rippling or kinking shall not be installed. Any conduits installed with wrinkles or kinks or otherwise in an unworkmanlike manner shall be replaced at no additional cost to owner.
- G. Precaution shall be exercised to prevent accumulation of water, dirt, concrete, or other foreign matter in the conduits during the execution of the project. Conduits in which water or foreign matter has been permitted to accumulate shall be thoroughly cleaned or the conduits runs replaced where such accumulation cannot be removed by methods approved the engineer.
- H. Permanently cap all spare conduits. Cap or plug conduit ends during construction to prevent entrance of foreign material.
- I. For metal conduit systems, provide electrically continuous conduit systems throughout.
- J. Where drilling through existing floors or walls, use x-ray or penetrating location device to identify steel elements prior to drilling. Avoid cutting existing reinforcing bars. If nicked or damaged, consult with a licensed structural engineer for repair and support methods and provide required materials and repair.
- K. Provide ground wire within all conduits sized per NEC code.

3.2 SUPPORT AND SEISMIC BRACING INSTALLATION:

- A. Individual suspended conduits and conduit racks shall be adequately braced for Seismic Restraint, as required per ASCE 7-10, section 13.3, latest edition. All life safety conduits, all conduits 2 inches and larger exceeding 12 inch suspension, and all multi-conduit racks exceeding 12 inch suspension shall be calculated and braced using the calculations methods of the ASCE and reviewed by the Architect/Engineer. Contractor shall perform the required calculations as early as possible in the contract and prior to installing suspended conduit racks.
- B. For 3 or more conduits install conduit racks with trapeze style hanging system, with stainless steel 3/8 inch all-threads hanging down to a Galvanized steel strut assembly. Provide conduit clips to rigidly clip conduit to strut.

- C. Provide a diagonal lateral seismic restraint braces at maximum 10 foot intervals (alternating directions), and a longitudinal brace (alternating directions) at maximum 30 foot intervals. Braces must be made of strut or similar rigid material, and will be tied directly to trapeze strut with hinges or rigid angles. Wire ties for bracing will not be acceptable. All hardware made for bracing shall be seismically rated.
- D. If a large number of suspended conduit feeders (more than 12 each exceeding 2-1/2 inches in size) are grouped together, the contractor shall review the layout with the structural engineer, provide estimated weights, and obtain approval for the proposed layout.
- E. Hanger rods shall be fastened to structure in an approved manner. Pullout resistance shall have a safety factor of 4.
- F. Support individual suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods.
- G. Support spacing shall be in accordance with the following table, in addition to these maximum spacing requirements the seismic support and bracing may require additional support and/or spacing supports less than the maximum distance indicated below; the most stringent requirement and shortest spacing distances shall be enforced.

Conduit Type:	Conduit Size:	Maximum Distance Between Conduit Supports:	Maximum Distance From outlet box, junction box, cabinet, fitting, conduit termination or bends larger than 22 degrees.
IMC/GRC	½" to ¾" 1" 1.25" to 1.5" 2" to 2.5" 3" and larger	10 feet 12 feet 14 feet 16 feet 20 feet	3 feet for all sizes
EMT	All Sizes	10 feet	3 feet
FMC	All Sizes	4.5 feet	1 foot
LFMC	All Sizes	4.5 feet	1 foot

3.3 FIELD CUTS AND THREADS:

- A. Cut all conduits perpendicular and square. Remove all sharp or rough edges and ream all burrs, inside and outside.
- B. Provide clean sharp threads on RMC and IMC. Engage at least five full threads on all RMC and IMC fittings.
- C. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of RMC or IMC.

- D. Apply coat of red lead, zinc chromate or special compound recommended by manufacture to conduit where conduit protective coating is damaged.

3.4 EXPANSION AND SEISMIC JOINTS

A. Expansion Joints:

1. All conduits three inches and larger where not cast in concrete shall be rigidly secured to the building structure on opposite sides of a building expansion joint with an expansion-deflection fitting across the joint, equivalent to O-Z/Gedney AXDX, installed per manufacturer's recommendations.
2. All conduits less than three inches where not cast in concrete shall be provided with junction boxes securely fastened on both sides of the expansion joint, connected together with 15 inches of slack (a minimum of 15 inches longer than the 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 three inch and larger, may be installed.

B. Seismic Joints:

1. All conduits shall be provided with junction boxes securely fastened on both sides of the seismic joint, connected together with 15 inches of slack (a minimum of 15 inches longer than the straight line length) flexible conduit and copper green ground bonding jumper. Prior to installation, verify with Architect that the 15 inches is adequate for the designed movement, and if not, increase this length as required.

3.5 CLEANING:

- A. Pull a mandril and swab through all conduits before installing conductors. Raceways shall be left clean and free of debris.
- B. Provide a pull string in all empty conduits.

3.7 COMMISSIONING AND FINAL INSPECTION:

- A. Contractor shall provide a time for access and inspection of raceway system for the Architect/Engineer. Correct all defects and flaws found prior to wall and ceiling installation and prior to cabling installation.
- B. Demonstrate electrical continuity at selected joints to the Architect/Engineer using an electrical ohmmeter.

- C. Demonstrate rigid seismic bracing to ensure minimal movement of the raceways on suspended racks in a seismic event. Demonstration shall be by pushing with at least 25 pounds force laterally and longitudinally at selected (mid-span) locations along the length of the suspended raceway rack. Rack shall not move more than 2 inches during these demonstrations.

END OF SECTION 260533

SECTION 260548 – SEISMIC RESTRAINT FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. This section includes seismic anchoring, and seismic bracing and restraints and other earthquake damage reduction measures for electrical systems, and electrical components. It complements seismic construction requirements located in other sections of the specification.
- B. Provide seismic bracing and support Design for all electrical and life safety components for the facility. Provide structural design of all components by a licensed Structural Engineer in the State of Utah, qualified as indicated in Quality Assurance section 1.5 below. All calculations and designs shall have a professional engineering stamp. The licensed structural engineer shall be hired by the Contractor as a payed consultant on the project upon bid award, and shall visit the project site during construction to verify the installation meets the calculations prepared by the Engineer.
- C. The 2015 IBC Chapter 16, section 1613.1; and the ASCE 7-10 American Society of Civil Engineering “Minimum Design Loads for Buildings and Structures”, section 13, shall define the minimum requirements for seismic design of nonstructural systems.
- D. Submit calculations and Shop drawings showing design intent, anchors, materials to the Architect/Engineer and the Authority Having Jurisdiction as a deferred submittal.
- E. It should be noted that the design of the seismic bracing depends heavily on the components and manufacturers purchased in the various electrical divisions. Other electrical divisions will need to have approved submittals prior to completing the submittals for this section. Time is of the essence in providing submittals promptly to avoid construction delays.
- F. Provide all seismic supports, and associated fittings as herein specified and shown on the associated drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

- A. Basic Material & Methods – Section 26 05 00.
- B. Raceways – Section 26 05 33.

1.3 REFERENCES

- A. International Building Code, Current Edition in use by Jurisdictional Authority.
- B. NFPA Bulletin 90A, Current Edition.
- C. UL Standard 181.

1.4 SYSTEM DESCRIPTION

- A. The Division 26 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, and bracing to comply with the following:
1. Short period design spectral response acceleration coefficient S_{DS} = _____.
Reference USGS site mapping tool for specific latitude and longitude of the site:
<http://earthquake.usgs.gov/designmaps/us/application.php>
 2. One-second period design spectral response acceleration coefficient S_{D1} = _____.
 3. Site Class D.
- B. The following components have a component importance factor I_p of 1.5:
1. Fire Alarm System
 2. Life Safety Egress Lighting
- C. All other components have an importance factor I_p of 1.0.

1.5 QUALITY ASSURANCE

- A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a Professional Engineer licensed in the state where the project is located, qualified with Seismic experience in bracing for electrical equipment, and referred to as the Seismic Engineer. Shop drawings included with deferred submittal for earthquake bracing and anchors from the restraint manufacturer shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 26, 27, and 28 equipment and systems shall be provided by a single firm.
- B. The above qualified Seismic Engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the electrical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.
- C. The Seismic Engineer shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer's design, the requirements of this specification section, and all seismic restraint requirements of the building code. Provide a certificate of compliance stating all Division 26, 27, and 28 raceway systems and equipment have been anchored and restrained in accordance with the requirements of the building code and ASCE 7. The certificate of compliance shall include the Seismic Engineer's signed Professional Engineer's seal. Include a copy of the certificate in each copy of the Operation and Maintenance Manual.

- D. The Division 26 Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases/skids/curbs designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the equipment submittals and certified to be code-compliant by the equipment manufacturer for seismic description loads defined above, with direct anchorage capability.
- E. Manufacturers shall be engaged in the manufacturing of industry accepted quality supports for conduits and raceways for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

- A. **Deferred Submittals:** Provide Seismic Certificate from manufacturer of all electrical equipment indicating that the equipment will withstand the forces, and has been tested using the IEEE method or calculated with the ASCE method using appropriate site acceleration and importance factors for the installed location and occupancy classification expected. Simply labeling it “Seismic Zone 4” under the old Uniform Building Code or “California Seismic approved” is not acceptable and will be rejected. Certificate shall be by an independent testing laboratory or licensed structural engineer. OSHPD certification may be substituted for independent certification, but must show on each component of the equipment with exact model number.
- B. **Deferred Submittals:** Provide drawings and details showing sizes, types, and assemblies of all seismic bracing and anchoring in sufficient detail to submit to the authority having jurisdiction at the State of Utah. Include stamped and signed calculations from a professional structural engineer licensed in the State of Utah.
- C. **Product Data:** Submit product data that illustrates and indicates type, styles, materials, strength rating, fastening provisions, and finish for each type and size of seismic restraint component used.
 - 1. **Anchor bolts and studs:** Tabulate types and sizes, complete with report numbers and rated strength in tension and shear as evaluated by an independent agency.
 - 2. **Cable and wire rope assemblies:** Tabulate types and sizes, complete with report numbers on rated strength in tension and shear as evaluated by an independent agency.
 - 3. **Details:** Contractor shall provide details of assembly arrangement, including attachment to differing types of structures. Show attachment locations, methods, spacing's, identifying components and listing their strengths. Indicate direction and value of forces (calculated or tested) transmitted to structure during seismic events.
 - 4. **The support seismic – restraint designs** must be signed and sealed by a qualified professional structural engineer, licensed in the State of Utah, paid for by the contractor.

- B. Coordination Drawings: Show coordination of seismic bracing of electrical components with other systems and equipment in the vicinity, including mechanical ductwork and piping. Show bridging elements to assure that all electrical components anchor to the structure, rather than into ductwork or piping supports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Provide products of a quality manufacturer located within the continental North American market. Supports made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable. The following manufacturer's products may be incorporated into the work:
1. Amber/Booth Company, Inc.
 2. B-Line Systems, a division of Cooper
 3. Erico, Inc.
 4. California Dynamics Corporation
 5. Hilti, Inc.
 6. Loos&Co: Seismic Earthquake Division
 7. Mason Industries
 8. TOLCO Incorporated; a brand of NIBCO Inc
 9. Unistrut; Tyco International, Ltd.
 10. GS Metals Corp.
 11. Powerstrut
 12. Thomas and Betts Corp.
 13. Vibro Acoustics
- B. Substitutions: Equivalent manufacturers are allowed at contractor's option, no submittals or prior approvals are necessary if supports meet specifications and are detailed in the deferred submittal by the licensed structural engineer.

2.2 COMPONENTS:

- A. Rigid Channel Support Systems: Shop or field fabricated assembly made of slotted steel channels with accessories for attachment to braced component at one end and to the building structure on the other end. Provide corrosion resistant coating.
- B. Restraint Cables: ASTM A 603 galvanized steel cables with end connections made of thimbles, brackets, swivels, and bolts designed for restraining cable service, and with a minimum of two clamping bolts for cable engagement.
- C. Hanging rod Stiffener: Steel tube or steel slotted channel support systems sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
- D. Bushings for Floor Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

- E. Bushing Assemblies for Wall Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- F. Resilient Isolation Washers and Bushings: One-piece, oil resistant, water resistant, molded neoprene, with a flat washer face.

2.3 ANCHOR BOLTS:

- A. Mechanical Anchor: Drilled in and stud-wedge or female-wedge type in zinc-coated steel for interior applications. Provide Stainless steel for exterior applications. Select anchors with strength required for anchor and as tested in accordance with ASTM E 488. Minimum length shall be eight times the diameter.
- B. Adhesive Anchors: Drilled in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injection polymer or hybrid mortar adhesive. Verify that Adhesive meets all LEED requirements. Provide anchor bolts in zinc-coated steel for interior applications. Provide stainless steel for exterior applications. Select anchors with strength required for anchor and as tested in accordance with ASTM E 488.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install seismic restraints in accordance to applicable codes and regulations as approved by authorities having jurisdiction.
- B. Examine structure for reinforcing and avoid structural reinforcing in concrete before drilling. Where depth and location is unknown, employ X-ray and/or radio frequency locating prior to drilling.

3.2 SUPPORT AND SEISMIC BRACING INSTALLATION:

- A. Conduit racks and suspended conduits shall be adequately braced for Seismic Restraint, as required per ASCE 7-10, latest edition.
- B. Install conduit racks with trapeze style hanging system, with stainless steel 3/8 inch all threads hanging down to a Galvanized steel strut assembly. Provide conduit clips to rigidly clip conduit to strut.
- C. Provide a diagonal lateral seismic restraint braces at maximum 10 foot intervals (alternating directions), and a longitudinal brace (alternating directions) at maximum 30 foot intervals. Braces must be made of strut or similar rigid material, and will be tied directly to trapeze strut with hinges or rigid angles. Wire ties for bracing will not be acceptable. All hardware made for bracing shall be seismically rated.

- D. If a large number of suspended conduit feeders (more than 12 each exceeding 2-1/2 inches in size) are grouped together, the contractor shall review the layout with the structural engineer, provide estimated weights, and obtain approval for the proposed layout.
- E. Hanger rods shall be fastened to structure in an approved manner. Pullout resistance shall have a safety factor of 4.
- F. Support individual suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods.

3.7 COMMISSIONING AND FINAL INSPECTION:

- A. Contractor shall provide a time for access and inspection of seismic support system for the Architect/Engineer, the Seismic Engineer they hired, the Owner, and the commissioning agent. Correct all defects and flaws found prior to ceiling installation and prior to cabling installation.
- B. Demonstrate rigid seismic bracing to ensure minimal movement of the raceways on suspended racks in a seismic event. Demonstration shall be by pushing with at least 25 pounds force laterally and longitudinally at selected (mid-span) locations along the length of the suspended raceway rack. Rack shall not move more than one inch during these demonstrations.

END OF SECTION 260548

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide new branch circuit panelboard as herein specified and shown on the drawings.
- B. Provide new breakers in existing panelboards and switchboards to remain, with manufacturer and breaker series to match the existing panel rating.

1.2 SUBMITTALS:

- A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit in accordance with the General Conditions, Division 01, and Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Breaker Panels: Square D, Siemens, General Electric, Cutler-Hammer/Westinghouse,
- B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 01, and Section 26 05 00.

2.2 EQUIPMENT:

- A. Panels shall be factory pre-assembled using bolt-on circuit breakers, equivalent to Square D NQOD series. Separate feeder lugs shall be provided for each feeder conductor.
- B. Breakers in branch panelboards shall be not less than 3/4 inch on centers. Each breaker shall be securely fastened to prevent movement and trims shall fit neatly and tightly to the breaker assembly. Two and three pole breakers shall be single breaker assembly rather than two or three single pole breakers with the handles tied together externally.
- C. Panel finish shall be a flat, light gray finish suitable for painting over or being left with factory finish. Flush mounted panels in finished walls shall be painted to match wall, paint and paint preparation to be as specified by Architect. Panel covers to be painted off wall, then installed over painted wall surface. Trims to be separately packed and protected from scratching and marring. Refer to labeling requirements in 26 05 00 Basic Materials and Methods.
- D. Panel covers to be "Door in Door" or "Hinged Trim Front" style to permit authorized personnel to open the outer door and have access to the entire interior of the can. The inner door shall access only the breaker handles. Provide flush stainless steel cylinder lock with catch and coil spring loaded door pull. All panels shall be keyed alike, but inner and outer doors shall not be keyed alike.

- E. Where grounding conductors are shown or specified, provide each panel and distribution center with grounding bus to which the grounding conductors shall be connected, each having its own terminal or lug.
- F. Panelboards rated 400 amps or less shall not exceed 6" depth.
- G. Provide Fully rated equipment greater than or equal to the interrupting capacities indicated on the drawings.
- H. Provide all copper bus bars, 100% rated neutral bus, and ground bus. Lugs shall be rated for copper only, CU-AL rated lugs shall not be allowed.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install surface mounted panelboards plumb and parallel to building lines. Fill all previous holes in masonry with sealant prior to installing new panelboard. Extend all existing circuit wires and conduits into the new panelboard and repair/replace or add conduit support within 3 ft of the panelboard as required by code.
- B. Where necessary, trace all branch circuits and note existing devices and circuits to remain on panelboard label.

3.2 LABELING:

- A. No brand labels or other marking shall be on the outside of the panels. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes; hand written revisions will not be acceptable.
- B. Provide engraved nameplate for all panelboards permanently mounted inside door for flush panels and on the outside face of the door for surface panels; include the following minimum information:
 - 1. Panelboard name
 - 2. Source feeding panel
 - 3. Voltage, Size (amps), number of phases, number of wires, and AIC rating
- C. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Black for normal power, Red for Emergency (Legally Required or Optional Standby) power.
- 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. Provide a permanent engraved label or include with the panel schedule information indicating the conductor insulation color for: (1) all ungrounded conductors (2) grounded conductor (3) equipment grounding conductor. This shall be documented at each panelboard in a readily visible location; refer to Wires and Cables Section 26 05 19 for conductor color coding.

3.3 COMMISSIONING:

- A. All current carrying devices and terminations within this section shall be inspected by performing a thermographic survey with normal load conditions applied to the system.
- B. Inspect distribution systems with thermal imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.
- C. Equipment shall detect emitted radiation and convert it to a visual signal.
- D. Perform thermographic survey during periods of maximum possible loading.
- E. Perform actions to correct any and all deficiencies.
- F. Provide a certified report including the following:
 - 1. Equipment to be tested
 - 2. Any and all discrepancies
 - 3. Temperature difference between concern area and reference area
 - 4. Probable cause of temperature difference
 - 5. Areas inspected, any areas and equipment which are unobservable
 - 6. Actual load conditions at time of inspection
 - 7. Provide photographs and thermograms of the deficient area
 - 8. Action to correct deficiencies
- G. Re-test all areas with deficiencies that have been adjusted to verify acceptable temperature differences.

END OF SECTION 262416

SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all switches, receptacles, and other devices as herein specified and shown on the associated drawings.
- B. Provide cord caps on existing welder machines to match and mate with the new receptacles. There are a total of 19 existing machines that will get cord cap replacements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Bryant, Arrow-Hart, Eagle, LeGrand, General Electric, Leviton, Hubbell are acceptable.

2.2 MATERIALS:

- A. The following list of wiring devices covers the most commonly specified items and establishes the grade of device. Should the Drawings indicate a device other than those listed herein without reference to catalog number, such device shall be of the same grade and manufacturer as like devices.

Single Pole Switches	Hubbell #1221
Duplex Receptacles - 20 amp	Hubbell #5362
Duplex Receptacles – GFCI	Hubbell
NEMA rated receptacles, 208 V	Hubbell

All wiring devices and plates to be specification grade. Receptacles shall be mounted vertically with the ground pin down unless otherwise noted.

- B. Color of devices and plates to be selected by Architect. Provide galvanized plates throughout the shop area.
- C. All device plates shall have panel and circuit designation labeled on face, and highlighted in a contrasting color.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Coordination with General Contractor and Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials such as paint over devices or interior of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables. Clean before device and coverplate installation.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- B. Provide a separate GFI type receptacle for each receptacle noted on plans as GFI. Standard receptacles fed from an up-stream GFI type receptacle are not acceptable.
- C. Install outlets and switches in a neat manner with plates covering all gaps between box and adjacent wall surface.
- D. Extend mudrings to flush out with surrounding panels and walls. In sheetrock, the mudring shall not be less than 1/8 inch recessed from surrounding wall surface, and shall not protrude more the 1/16 inch.
- E. Faceplates, devices, and boxes shall be square with floor, and door lines. Outlet plates of adjacent outlets shall be vertically aligned to within 1/16 inch.
- F. Bond ground terminal of each receptacles to equipment ground conductor, and provide green bonding jumper to box grounding screw when used with metal boxes.
- G. Devices to be installed flush with faceplate. Do not overtighten and crack or warp the coverplate

3.2 DEVICE INSTALLATION:

- A. Replace all devices that have been in temporary use during construction or that show signs of where or damage, that they were installed before building finishing operations were complete.
- B. Keep each wiring device in its package or otherwise protected until it is time to install and connect conductors.
- C. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
- D. Provide pigtailed to connect building branch circuits to devices using pigtailed that are not less than 6 inches in length.
- E. Side wiring to binding-head screw is the required method of termination when available. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw and torque as recommended by the manufacturer.
- F. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtailed for device connections.
- G. Tighten unused terminal screws on the device to minimize risk of accidental shock.

- H. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- I. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- J. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening

3.3 LABELING:

- A. Provide self-adhesive labels for all switches and receptacles in compliance with Part 3.3 of Section 26 05 00.
- B. Where switches control remote lighting or power outlets, or where switches in the same outlet (two or more) serve different purposes, such as light, power, intercom, etc. or different areas, such as corridor and outside, provide self-adhesive labels clearly indicating the function of each switch or outlet.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or plug in device with illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Using the test plug of the testing instrument, verify that the device and its outlet box are securely mounted.
 - 2. Test at least one receptacle per circuit, or 20 percent of installed receptacles with instrument or testing device and write down results for O&M manuals. The tests shall be diagnostic, indicating potential damaged or misconnected conductors, poor connections, inadequate ground current path, defective devices, or similar problems.
 - 3. Line Voltage: Where testing instrument or device indicates problems, test the actual voltage to the device. Acceptable range is 107 to 127 V.
 - 4. Ground Impedance: Where test instrument or device shows ground issues, test the value of ground resistance. Values of up to 5 ohms are acceptable.
 - 5. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
- C. Correct circuit conditions after testing, remove malfunctioning units and replace with new ones, and retest as specified above.

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- D. Provide device testing report in O&M manuals. Indicate pass/fail results and actual values before and after corrections.

END OF SECTION 262726

SECTION 262900 – MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Extent of motor controller and starter work is indicated by drawings, schedules and specified herein.
- B. Work includes the complete installation, electrical connections, testing, and commissioning of starters and combination disconnect/starters.
- C. Verify compatibility of motor controllers and starters with motors supplied under Division 22 and 23. Review Division 22 and 23 specifications, plans, schedules, etc., to issue compatibility.

1.2 QUALITY ASSURANCE:

Comply with NEC, and NEMA Standards as applicable to wiring methods, construction and installation of motor controllers, starters, and combination disconnects/starters. Provide complete packaged units which have been UL-listed and labeled by Underwriters Laboratory or ETL Testing Laboratories, Inc. Note: The entire unit shall carry the label, not just components.

1.3 SUBMITTALS:

- A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit manufacturer's installation instructions under provisions of general conditions.
- B. Submit dimensions of all units.
- C. Equipment list and ratings: list motors to be controlled, with motor identification, function and location, starter characteristics, size, voltage, phase and current ratings, control equipment and accessories as specified, scheduled or noted.
- D. Coordinate all motor starter sizes and requirements with Division 22 and 23 Contractor prior to submittal for approval.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. COMBINATION STARTER/DISCONNECTS – STAND ALONE UNITS: Subject to compliance with requirements, provide products manufactured by one of the following:
 - Square D
 - GE

Siemens
Cutler Hammer

2.2 COMBINATION STARTERS

- A. Starters: combination type with fused disconnect switch with time delay dual element, 3 pole, UL Class RK-5 fuses as scheduled; full voltage, non-reversing magnetic starter unless otherwise shown or noted. Provide quick make, quick break disconnect. Starters shall have electronic resettable thermal overload elements for all three phases with settings sized for the actual final motor nameplate full load current. Minimum starter size shall be NEMA 1. For sizes 4 and above, provide electronic soft start system starter. Exterior starters shall be rated NEMA 3R.

2.3 STARTERS

- A. Each magnetic starter shall include:
- a. Hand-Off-Automatic selector switch unless otherwise shown or noted. HOA switch to be of a type that is field convertible to "On/Off" or "Auto/Off".
 - b. A thermal element reset button.
 - c. A red transformer type pilot light to indicate when the motor is running.
 - d. A 120V holding coil.
 - e. A 480/120V control transformer with primary and secondary fuse protection; of sufficient VA to handle the holding coil and associated controls. One leg of the transformer secondary shall be grounded.
 - f. Two normally open and two normally closed auxiliary contacts.
 - g. A nameplate engraved with motor identification and Horsepower, Nameplate, HOA switch, reset button and pilot light shall be mounted in cubicle door. A door mounted keypad display with indicators, allowing user to program
- B. Each electronic solid state starter shall include the items indicated above, plus the following items:
- a. Ramp time, type of start, type of step. Display to show motor current, power factor, and fault status.
 - b. Phase loss protection and phase reversal protection.
1. The solid state starter shall utilize an 18 pulse converter design, to maintain minimal AC line distortion and low harmonics.
 2. The Solid State Starter and all components shall be rated to 100,000 AIC.

4. The starter shall have an adjustable ramp start of 0.5 to 180 seconds, and an adjustable current limit of 0% to 85% of Locked Rotor Current. The starter shall also have an adjustable Soft Stop from 0 to 60 seconds.
5. The starter shall have fault isolation, to automatically disconnect the power supply to protect the motor in the event of a semi-conductor fault.
6. The starter shall be equipped with an Electronic Timing Relay, adjustable from 0.1 to 60 seconds, to delay the start of the motor.
7. Provide an elapsed Time Meter on door to indicate pump run time.
8. Finish: Fronts shall be made of cleaned phosphatized steel with rust-inhibiting primer and electro-deposited baked enamel finish, manufacturer's standard color.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Starters shall be installed level, plumb and anchored to the mounting surface in accordance with the manufacturer's instructions. The equipment shall be protected if stored during construction.
- B. Seismic restraints: Provide anchor bolts, angle irons and fasteners to attach the combination starters rigidly to the building structure per IBC seismic requirements.
- C. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- D. Touch-up scratched or marred surfaces to match original finish.
- E. Clean interiors of motor controllers and starters prior to energization.

3.2 LABELING:

- A. Where changes are made to existing motor controllers, provide new labeling to accurately reflect the changes; hand written revisions will not be acceptable.
- B. Provide engraved nameplate for all motor controllers mounted on the outside face of the Controller; include the following minimum information:
 1. Name of Motor or Equipment Controlled
 2. Source feeding Motor Controller
 3. Voltage, NEMA starter size, number of phases
 4. Disconnect size in amps (where applicable), fuse size in amps (where applicable)

- C. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Black for normal power, Red for Emergency (Legally Required or Optional Standby) power, Orange for UPS power.

3.3 TESTING:

- A. When all motors are connected and the pre-energizing tests have been completed, the contractor shall operate the equipment to demonstrate that all control equipment and overcurrent protective devices perform as specified. Any deficiencies found shall be corrected and tests repeated. All test results and dates shall be recorded and submitted to the Engineer and the Owner's Representative with statement certifying that the equipment is safe and ready for use.

END OF SECTION 262900

SECTION 265100 - LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide light fixtures with lamps and accessories as herein specified and shown on the drawings.

1.2 QUALITY ASSURANCE:

- A. If the catalog number of a specified fixture should conflict with the fixture description or the general lighting specifications, such conflicts shall be brought to the attention of the Architect prior to bidding.
- B. The dimensions shown on the luminaire schedule are for general reference only. Refer to the manufacturer's shop drawings for exact dimensions prior to rough in.

1.3 SUBMITTALS:

- A. Submit product data and shop drawings for fixtures, ballasts, and lamps in accordance with the General Conditions, Division 1, and Section 26 05 00.
- B. Verify that fixture description matches that which is indicated by the specified catalog number.
- C. All features mentioned in the fixture list shall be marked on the submitted items.
- D. Submit written confirmation that dimming ballasts and dimming controls are compatible.
- E. Submit Operation and Maintenance data in accordance with the General Conditions, Division 1, and Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. See Luminaire Schedule for acceptable manufacturers.
- B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 1, and Section 26 05 00.
- C. Substitution requests for fixtures equal to those specified shall include complete construction and photometric data including, if applicable, candlepower distribution curve, spacing to mounting height ratio, table of coefficients of utilization, isofotcandle curve, ANSI beam spread classification, efficiency, etc.

- D. Submittals and substitution requests for fluorescent fixtures shall include the sheet metal gauge of the housing and the lens thickness, material, and pattern.

2.2 MATERIALS:

- A. Polystyrene lenses and lenses less than 0.125 inches nominal thickness shall not be permitted unless otherwise noted.
- B. Provide luminaires with Area Coverage, damp, or wet label if required for the application indicated.
- C. All luminaires shall be free of light leaks.

2.3 DRIVERS AND BALLASTS:

- A. All drivers and ballasts shall be capable of providing reliable operation of the lamps at the lowest temperature normally encountered. The contractor shall confirm that the ballasts are appropriate for the ambient conditions.
- B. The contractor shall verify the ballast voltage prior to submittal.
- C. Drivers and Ballasts deemed excessively noisy shall be replaced without cost to the Owner.
- D. Spare Parts: Provide a minimum of three spare Drivers for each type of LED light fixture.
- E. DIMMING DRIVER LED: Provide integral 0-10 volt dimming driver capable of continuous dimming that works with any standard 0-10V dimmer, unless noted otherwise on Luminaire Schedule:

- UL listed and CSA certified.
 - Comply with IESNA LM-79 and LM-80 standards.
 - Recognized Testing Laboratory listed, thermally protected, resetting, Class P, For use in insulated ceilings.
 - Power factor equal to or greater than 90%.
 - Meet all current Federal, State and Power Co. efficiency and efficacy standards, and rebate program requirements.
 - Meet all current ANSI, IEEE, and FCC regulations for EMI/RFI, harmonic distortion, and transient protection.
 - Compatible with occupancy sensor switching.

Dimming will be future use, initial design has 100% full output.

2.4 LAMPS:

- A. Permanently wired LED fixtures shall have LED lamps, on removable/replacable metal arrays.
- B. Screw-in base fixtures shall have LED replaceable lamps

- C. All lamps and fixtures shall be in proper operation at the time of acceptance.
- D. SPARE LAMPS: For Screw –in lamps, provide ten percent spare lamps, with a minimum of two, for each size and type used.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Luminaires installed under this work shall be properly and adequately supported from the building structure except where ceiling construction or other provisions are specifically designed to support the fixture units. Fixture support systems shall provide a safety factor of four. This shall apply to chains, hangers, anchors, clamps, screws, and all other hardware and appurtenances associated with the support system.
- B. Fixture supports shall provide proper alignment and leveling of fixtures, and shall be arranged to maintain the alignment at all times. The final decision as to adequacy of alignment shall be given by the Engineer/Architect.
- C. All light outlets shall be supplied with a fixture. Outlet symbols on the drawings without a type designation shall have a fixture the same as those used in similar or like locations.
- D. Fixture stem or chain lengths for industrial reflector or bare lamp strip fixtures shall be appropriate for the space and for coordination with other work such as ducts and piping. Provide swivel hangers for stem-hung fixtures.
- E. Fixtures shall be left clean at the time of acceptance of the work and every lamp shall be in operation. The responsibility for cleaning or protecting fixtures from dirt, dust, paint, debris, etc. shall rest with the Contractor performing this division of work.
- F. Prior to the purchase of any luminaire, the finish shall be verified with the Engineer/Architect and the voltage shall be verified based on the panelboard voltage.
- G. Fixtures of a given description may be used in more than one type of ceiling. Consult the Architectural Reflected Ceiling plan to obtain this information. Some ceiling types may have changed immediately prior to bidding or by addenda or change order and the changes may not be reflected in the fixture list or fixture designations as shown on the plans. The contractor shall compare the electrical plans with the reflected ceiling plan and confirm that the specified fixtures are compatible with the ceiling system prior to ordering.
- H. Provide seismic support wires for all recessed fixtures where ceiling framing is not designed for fixture support.
- I. Where fixtures are installed in physically restricting spaces, the contractor shall verify that the fixtures will fit the space prior to ordering.

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3.3 WARRANTY:

- H. Provide a 5 year complete parts and replacement labor by manufacturer for all LED Drivers.

END OF SECTION 265100

SECTION 283100 – FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. The Contractor shall interconnect new devices to existing fire alarm system, as specified herein and indicated on the drawings.
- B. The system signals initiating devices, audible and visual alarm devices, a wiring system and all accessory devices required to provide a complete operating system. Equipment wiring shown on the drawings is diagrammatic and shows only the intended function. New notification devices shall be synchronized with existing notification devices.
- C. The system shall comply with the applicable provisions of the National Fire Alarm Code (NFPA 72), Americans with Disabilities Act, and meet all requirements of the local authorities having jurisdiction. All equipment and devices shall be listed by the Underwriters' Laboratories, Inc., or approved by the Factory Mutual Laboratories.
- D. NFPA 72 requires audible devices to be heard above the ambient noise levels in all areas of the building. Audible devices shown on the drawings represent a generic layout. Different devices have varying dB output levels and may not provide the performance required by NFPA 72 based on the device layout shown on the drawings. The Contractor shall review the layout with his fire alarm supplier prior to bidding, and if necessary, add additional audible devices to meet the alerting requirements of NFPA 72. This is a performance specification. Any additional devices required shall be shown on a plan and submitted with the shop drawings. Shop drawing checking by the Engineer will be only for aesthetic coordination and not for performance as a warning system.

1.3 SUBMITTALS:

- A. Submit complete and descriptive shop drawings in accordance with Division 1 and Section 26 05 00.
- B. Submit plans and specifications to the governing Building Official. Obtain his written acceptance of, and procure and pay for all permits for the system prior to beginning work and ordering equipment.

1.4 ELECTRONIC MEDIA:

- A. The Engineer will furnish electronic media for the Contractors use if requested. Title blocks will be removed and small addenda drawings will be removed as well. Addenda and change orders will usually not have been incorporated into the files and it is the Contractors responsibility to add that information. The

Contractor or Vendor that will ultimately use the files will be required to sign a hold harmless agreement.

- B. Conversion to formats other than the current version of Autocad will be billed based on time expended in making the conversion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Silent Knight
- B. Requests for substitution of other products will be considered if submitted in accordance with the general conditions and Section 26 05 00.

2.2 EQUIPMENT:

- A. The existing IntelliKnight fire alarm control panel shall detect the operation of any new signal initiating device, display on the control panel the English language description of the alarm and the area of the alarm condition, print on the printer the alarm type, location, time, and date, close all fire and smoke doors, operate all alarm and auxiliary devices and in addition, shall function as follows:
 - A. A trouble lamp and trouble buzzer, operating together shall signal any trouble condition. Failure of the building service supply, derangement of system wiring, or alarm condition shall cause the trouble lamps to come on and the trouble buzzer to sound.
 - B. A self-restoring silencing switch shall be provided to silence the trouble buzzer which shall be so arranged that the trouble lamp will remain on until the system is restored to normal.
 - C. All alarm signals shall be automatically locked in at the control panel until the operated device is returned to its normal condition, and the panel is manually reset.
 - D. A switch shall be provided on the control panel for silencing the alarm devices. The manual switch and the alarm silencing switch shall be self-restoring type which cannot be left in an abnormal position.
 - E. Each circuit shall be supervised and shall be so arranged that a fault condition in any circuit, or group of circuits, will not affect the proper operation of any other circuit. Supervision shall be the NFPA style appropriate for the occupancy type.
 - F. Circuit fuses shall be provided in the control panel for each signal initiating circuit and each alarm circuit. A blown fuse shall cause the audible and visual trouble signals to operate.

- G. All control panel components shall be contained in a 16 gauge steel cabinet with hinged door and key lock finished in red baked enamel.
 - H. Provide a digital transmitter with terminals and other necessary facilities in the control panel to permit transmission of trouble and alarm signals over leased or privately owned telephone cable to a remote station receiving panel. Provide two RJ31X telephone jacks at the fire alarm panel and extend two telephone cables to the main telephone board for this purpose.
 - I. Provide a key operated "Drill" switch to simulate operation of an initiating device. The "Drill" switch shall not trip the device which transmits a signal to the fire department, operate the elevator return system, or roll down guillotine type fire doors.
 - J. The contractor shall determine and furnish the appropriate number of transponders (data gathering panels) needed for proper operation. All transponders shall have at least 20 percent spare points.
 - K. The panel shall be approved as a limited energy system.
- B. Audio/Visual Alarm Signal
- A. Furnish and install new notification devices to match existing combination audio-ADA visual alarm assemblies.
 - B. All new visual strobes shall be 1 Hz synchronized flash and shall comply with ADA Standards.

2.3 SOFTWARE:

- A. The Field Configuration Program shall provide all of the programmable operating instructions for the system. The resident program shall be stored on non-volatile EPROM.
- B. Programming shall be performed at the location of the fire alarm control using a lap-top computer. It shall be possible to program the system without shutting the system down. Programming shall be done off line. Installing the program into the system shall be done by one man from in front of the control panel using a data transfer command. A hard copy of the system programming software shall be made available to the facility manager for his/her use at his/her option. Software will allow the user to reprogram system points, add system points, add or change point descriptions and update the data file.
- C. Programmed control point activation shall include selective control of HVAC, door holder release, elevator recall, fire pump control, stairwell pressurization fans, etc.

2.4 INITIATING & WARNING DEVICES:

- A. Call stations shall visually indicate if they have been tripped and shall not have glass or breakable element in them. A special key must be used to reset them.
- B. Audible devices shall be as indicated on the drawings. Horns shall be semi-flush mounted. Chimes shall be electronic type with adjustable volume. Strobe lights shall be behind a white translucent cover with the word "FIRE" on it in red letters. No single audible device shall have a sound level over 100db.
- C. Annunciators shall be a display module indicating alarm/trouble conditions in English language with the description and location of the event.
- D. Every initiating device shall have a unique address.
- E. Provide an addressable relay at one of the energy management system DDCU panels to indicate that the fire alarm system is in alarm.

PART 3 - EXECUTION

3.1 WIRING:

- A. Furnish and install all required wiring in accordance with local and National codes.
- B. Unless otherwise specified, minimum wire size shall be 16 gauge for audible alarm circuits, and 18 gauge for signal initiating circuits. Strobes shall be wired separately from audible devices, including combination horn/strobe units.
- C. All point monitors and relays for control of auxiliary devices such as fans, dampers, solenoids, elevators, etc. are to be located within three feet of the device they control.
- D. Mount all detectors in accordance with the requirements of NFPA 72E.

3.2 LABELING:

- A. Where changes are made in existing panels, provide new labeling to accurately reflect the changes; hand written revisions will not be acceptable.
- B. Provide permanent engraved labels for all fire alarm control panels, notification appliance circuit (NAC) power supply panels, transponder panels, and speaker system panels in compliance with Part 3.3 of Section 26 05 00. Include the following information:
 - A. Panel name, date of installation (month/year)
 - B. Circuit number feeding the panel
- C. Provide self-adhesive labels for the following devices in compliance with Part 3.3 of Section 26 05 00:

- A. All initiating devices (smoke detectors, heat detectors, duct detectors, beam detectors, pull stations, monitor modules, control modules, etc.); for addressable devices provide unique address, for zone devices provide zone address.
- B. All notification appliances (horn/strobes, strobes, horns, etc.); provide NAC panel supplying device along with circuit number.
- D. Label all fire alarm system junction boxes with a permanent black marker indicating circuits.
- E. Fire alarm system conduit shall be labeled by one of the following means unless raceway is run exposed within finished spaces:
 - A. Red painted conduit or MC cable (if MC cable is allowed)
 - B. With 2" wide red painted or red taped bands on the conduit at no less than 8 feet on center increments and at every end or termination of the conduit.
- F. Fire alarm system junction boxes shall be provided with red coverplates unless they are installed exposed within finished spaces.
- G. Identify the circuit disconnecting means for the fire alarm equipment as "FIRE ALARM CIRCUIT" with red identification.

3.3 DEVICE LOCATION

- A. Consult Engineer for minor relocations of devices that may be required to avoid obstructions, or for ease of installation or concealment. Mark all such relocations on record drawings. Contractor shall relocate devices up to 15 feet without any additional charge to the contract.
- B. Devices that are not required to be installed at the final sign-off of the fire alarm system by the Fire Department shall be issued to the Owner for credit.
- C. System programming cost shall also be included to program the new devices.

3.4 FIELD QUALITY CONTROL:

- A. A factory trained representative of the manufacturer shall supervise the prefinal testing of the system. Pretest all installed devices to ensure compliance prior to the final test.
- B. The final test shall be subject to the approval and acceptance of the responsible Architect/Engineer, and the Fire Marshal. Provide all appropriate equipment to complete the testing.
- C. On completion of the acceptance tests, the Owner or his representative shall be instructed in the operation and testing of the system.

3.5 CERTIFICATION/CLOSEOUT:

- A. Submit a statement to the Engineer that indicates the system has been designed, tested, and installed in accordance with all applicable codes and regulations.
- B. Submit diskette or CD, with all appropriate programming updates to the owner.
- C. Submit testing report to the Engineer and Fire Marshal showing results of tests.

3.6 WARRANTY

- D. Submit letter of warranty, guaranteeing the new portion of the fire alarm system parts and labor for 2 years. Provide a 24 hour response upon failure of any component of the fire alarm system. The vendor and the contractor are required to participate as necessary for any warranty work during the warranty period.

END OF SECTION 283100