

SECTION 220529 - HANGERS & SUPPORTS

PART 1 NOT USEDPART 2 PRODUCTS

2.01 MATERIALS AND SPECIALTIES:

- A. Perforated strap, chains, and tie wire shall not be permitted in any form to support, hang, or secure pipe.
- B. Pipe hangers, supports and accessories shall be the standard products of Grinnell Co. , PHD Manufacturing, Michigan Hanger Co., or B-Line Systems or other prior approved manufacturer.
- C. For chilled water, chilled/hot water, or HVAC piping, hangers shall be the equivalent of Auto-Grip "Insul-Speed" zinc electro-plated hanger, ASTM Type L.S. with permanently attached coated shield 12" long x 18 gauge steel. Flexible Aerotube, fiberglass or other low-density insulation shall not be used at insulation shields. A 12" length of Foamglas or other approved high-density insulation with fire resistant vapor barrier shall be used at each insulation shield. Details must be approved prior to installation. Where trapeze hangers are used, use insulation protection devices as above less pipe rings.
- D. For domestic hot, tempered, and cold water piping, roof or overflow piping, and condensate drain lines from air handling equipment where run above ground, hangers shall be oversized galvanized clevis with integral factory installed insulation shield. Hangers shall be spaced not over 6' apart for 1-1/2" and smaller pipes and not over 8' apart for pipes 2" and larger. Insulation shall be continuous through the hangers. Hangers shall be equal to PHD model #455 or Michigan Hanger #403.
- E. For cast iron or other ferrous piping run above ground, hangers shall be galvanized clevis. Hangers shall be spaced not over 5' apart on cast iron and 8' apart on other steel piping. Locate hangers as close as possible to cast iron hubs or bands. Hangers shall be equal to Michigan Hanger Co. #401.
- F. For "plastic" drainage piping systems; PVC, CPVC, Polypropylene, PVDF, or other, run above ground, hangers shall be galvanized V clevis hangers with support trough in 10' lengths. Hangers shall be spaced at each end of support trough, less than 10' oc. Hangers shall be equal to PHD #450 V and trough shall be equal to #450 T.
- G. For "plastic" water or sprinkler piping systems, PVC and CPVC, run above grade, hangers shall be galvanized, hangers shall be spaced a maximum of 4' apart.

- H. Pipe rings for copper tube shall be Fee and Mason Figure 363 or "Auto-Grip" Symbol 19-500A Universal ring (copper plated).
- I. For support of all other overhead horizontal pipes use "Auto-Grip" Symbol 19-400A Universal hanger rings, Grinnell Figure 104 or Figure 260 adjustable clevis ring (on piping 3-1/2" size and over).
- J. Inserts shall be Unistrut Sections or Grinnell Figures 279, 281 or 285 wrought steel with proper size nut.
- K. Beam clamps shall be Grinnell as follows: Figure 131 I-beam clamp, Figure 226 Universal channel clamp or Figure 267 Simplex top beam clamp. Figure 87 C-clamp with locknut and retaining clip may be used within its recommended maximum load rating.
- L. Specially designed hangers and/or supports shall be provided as detailed on the drawings and/or complying with the requirements of the specification.
- M. All hangers, supports, hanger rods and accessories shall be Zinc-plated and/or Hot-Dip Galvanized unless otherwise specified.

PART 3 EXECUTION

3.01 INSTALLATION:

- A. Generally, horizontal overhead runs of piping shall be hung with adjustable, wrought iron or malleable-iron pipe hangers. Chain strap, perforated bar or wire hangers will not be permitted. Hanger rings shall be copper or copper plated when in contact with copper pipe.
- B. Trapeze hangers constructed of angle or channel iron sections may be used in lieu of individual hanger rings where multiple pipes run parallel at the same elevation and grade. Details must be submitted for approval.
- C. Pipe clips, straps and hooks may be used where approved for the service, and shall be copper or copper plated when in contact with copper pipe.
- D. The exterior wall of the building shall not be pierced by hanger and/or support bolts.
- E. Supplementary steel supports shall be provided for proper support of piping and/or equipment which cannot be supported directly from the building structure.
- F. Inserts and bolts for supporting piping and/or equipment shall be placed in concrete or masonry areas before concrete is poured and as masonry is built. Where multiple pipes

run parallel, approved Unistrut Channel sections may be used in lieu of individual inserts. Inserts and/or unistrut sections shall not be used in pre-cast concrete or in concrete less than 3-1/2" in thickness.

- G. Beam clamps shall be used insofar as possible where piping and/or equipment is supported from building structural steel. Punching of building structural steel will not be permitted. Support brackets electric welded to the building steel will be considered in lieu of beam clamps. Details must receive prior approval of the Engineer.
- H. Supporting brackets and hangers in plastered, painted or tiled areas shall be installed before such areas are plastered, painted or tiled.
- I. Hanger rods penetrating finished ceilings shall be provided with the equivalent of Grinnell Figure 133 spring ceiling plates.
- J. Spacing of piping hangers and/or supports shall conform to the following unless otherwise specified, detailed or approved:
 - 1. Steel pipe: 8'-0" maximum.
 - 2. Hard drawn copper pipe: 1-1/2" and smaller - 6'-0" maximum; 2" and up - 8'-0" maximum.
 - 3. Soft copper tubing: 5'-0" maximum.
 - 4. Cast iron pipe: at or near each hub or band.
 - 5. Underground cast iron and tile: body of pipe firmly bedded on solid ground.
 - 6. Soil, waste, drain, and vent stacks: permanent support at base. Provide "riser" clamps at each floor, and at 10' intervals if floor height exceeds 14'.
 - 7. Generally: Provide additional hangers where a number of valves, fittings, etc., are assembled and at least one hanger not more than 2' from where a change in direction takes place in any pipe line.
- K. Anchors shall be provided to confine expansion movements of pipes to definite expansion members.
- L. Specially designed hangers and/or supports shall be provided for any unusual conditions of installation. All specially designed hangers and/or supports must receive approval prior to fabrication and installation.

- END OF SECTION 220529 -

SECTION 230000 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. The work of this Division consists essentially of but shall not be construed as limited to:
 - 1. Plumbing System.
 - 2. Mechanical Systems (Heating, Ventilating, Air Conditioning Systems, exhaust systems, etc.).

1.2 CODES AND STANDARDS:

- A. The following standards are applicable:
 - 1. International Plumbing Code, Mechanical and Fuel Gas Codes.
 - 2. NFPA 90A.
 - 3. NFPA 90B.
 - 4. Underwriters Laboratories, Inc. (UL).
- B. In addition to the above, comply with ASHRAE Guides and local codes. Obtain all required permits and comply with local inspection requirements.
- C. Compliance: When materials or equipment must conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electric Manufacturers Association (NEMA), and Underwriters Laboratories (UL), proof of such conformance shall be submitted to the Engineer for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections.
- D. Construction Standards and/or Codes: The latest editions of standards and/or codes referenced, with all amendments as of the date of the opening of bids, shall govern the installation of all work and are adopted and incorporated into the contract documents and made a part thereof by reference, provided, however, that the drawings and specifications shall be adhered to in all cases where they call for quality of materials, quality of workmanship, or quality required by such standards and/or codes, and provided also that there may be no variances from the plans and specifications except to the extent that the said variance shall be necessary in order to comply with such standards and/or codes. It shall be the responsibility of the Contractor to familiarize himself with the requirements of such standards and/or codes. If there are any express requirements in the plans or specifications which are at variance therewith, all changes in the work necessary to eliminate the said requirements and make the work conform to standards and/or codes shall be accomplished in the manner provided in the contract for changes in the work.

- - END OF SECTION 230000 - -

SECTION 230500 - MECHANICAL PROVISIONS

PART 1- GENERAL

1.1 GENERAL PROVISIONS:

- A. The provisions of the Instruction to Bidders and of the Special Conditions, General Conditions, and Supplementary Conditions of this specification shall govern the work in this division. The attention of this Contractor is directed to the Submittal of Substitutions or Supplementary Conditions concerning substitution of materials and equipment.

1.2 MATERIALS:

- A. Material References: Equipment or materials are described by reference to manufacturer's published data, such data will be used as the basis for comparison with proposed substitute equipment or material. Such publications are available for review in the offices of the Engineers, and the Contractor is referred to them for full information.
- B. Use of Substitute Equipment of Materials: The mechanical, electrical, structural, architectural, space conditions and other features of the overall project design have been based on the requirements of the scheduled products. Should approved products other than those scheduled be used, the Contractor shall submit for approval a schedule setting forth in what respects the overall project design (mechanical, electrical, structural, architectural or space conditions) must be modified in order to permit proper installation and operation of the approved products. Extensive or unreasonable modifications shall be considered cause for rejection of such products. In the event the required modifications are approved, the Contractor shall bear all costs related thereto.
- C. Material List: Within thirty (30) days after award of the contract, the Contractor shall forward to the Engineer a complete list of all materials and equipment to be used in the work. The intent to use the exact material or equipment scheduled or specified does not eliminate the responsibility for submitting such a list. Should the Contractor fail to submit such a list, then the right is reserved for the Engineer to select a full line of material and equipment which shall be used in the work at no additional cost to the Owner.

1.3 GENERAL REQUIREMENTS:

- A. Mechanical Drawings: The drawings specifically applicable to "Mechanical" are identified by the prefix "M" and "P". The Contractor shall refer to all other drawings for additional details such as ceiling heights, finishes, dimensions, building materials, door openings, and other architectural, structural, mechanical and electrical features which may affect "Mechanical".
- B. Interference: The mechanical drawings are generally diagrammatic and the Contractor shall provide offsets in the work so that interferences between piping, ducts, conduit, equipment, apparatus, architectural, and structural work will be avoided.
- C. Shop Drawings: Shop drawings required under "Mechanical" shall be included in a single submittal brochure including outline drawings, descriptive literature and/or specification data covering plumbing fixtures, major components of each mechanical system, insulation, and specialty items. Data shall show performance, internal wiring diagrams, roughing-in dimensions, space requirements, construction features and external wiring and piping

connections. Where data includes information not applicable to this project, the information which is applicable shall be clearly identified for easy reference. A cover sheet shall be included, listing manufacturer and model number of each item submitted.

- D. Existing Utilities and/or Concealed Work: The locations, sizes, elevations, and other data indicated on the drawings relative to existing utilities and/or other work below the surface of the ground or in otherwise concealed locations are based on the information available during the design. Should actual conditions be at variance to conditions indicated by the drawings and specifications, all changes in work necessary to correct such variance and make the work conform to actual conditions shall be accomplished in accordance with applicable portions of the contract documents.
- E. Space Conditions:
1. All piping, ductwork, apparatus, equipment, and related work shall fit properly into the provided spaces in the building or property, and shall be introduced into the spaces at such time and in such manner as to not cause damage to the building structure or property.
 2. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. This provision includes, but is not limited to, valves, traps, cleanouts, motors, controllers, drain points, etc..
- F. Excavation, Trenching, and Backfilling: All excavation, trenching, and backfilling necessary to receive any mechanical work shall be provided hereunder, and shall be performed in strict accordance with the applicable requirements of another division.
- G. Painting: Any required painting, except for the standard factory coat furnished on equipment, touch-up painting, and/or other painting as may be expressly required hereunder, will be provided under section entitled, "Painting"; however, the Contractor shall leave all mechanical work and equipment clean and free of any grease, dirt, rust, and other foreign matter and in suitable condition for proper painting.
- H. Access Doors: Access doors shall be furnished to provide access for service and maintenance of any concealed valves, cleanouts, air vents, damper operators, or other equipment normally requiring servicing or maintenance, and for which other means of ready access is not built into the building or structure.
- I. Roof Flashing: Pipes, ducts, or other mechanical work passing through the roof shall be flashed and made water-tight in a manner approved by the manufacturer of the roofing material and complying with roof bond requirements.
- J. Equipment Supports and/or Foundations: Unless expressly stipulated otherwise, provide all supports, concrete foundations and/or pads required for proper installation of the equipment furnished under "Mechanical". Concrete work shall conform in all applicable detail to the requirements of "Concrete". Foundations requiring anchor bolts shall be constructed with such anchor bolts securely embedded in the concrete. Bolts shall have bottom plates and pipe sleeves unless otherwise detailed on the mechanical drawings.
- K. Controls, Switches, Starters, Etc.: Shall be identified with etched plastic or other permanent type name plate as approved. Name plate shall show function, system, etc..
- L. Operating and Maintenance Data and Instructions:
1. Prior to making request for final inspection, the Contractor shall put all mechanical systems and equipment into operation, and shall make all tests and adjustments. The Contractor shall furnish proper instructions to the Owner in the presence of the Engineer or the Engineer's designated representative concerning operation and maintenance of all mechanical and related electrical equipment.

2. For all items of mechanical or related electric equipment or apparatus installed which requires operation of maintenance after occupancy, the Contractor shall furnish four (4) complete brochures and data as prepared and published by the manufacturer covering details of operation and maintenance. Brochures and data shall be delivered to the Engineer for transmittal to the Owner.
3. Each brochure shall contain one (1) copy of each "shop drawing". Shop drawings as originally submitted and approved shall be revised if necessary to reflect the work "as-built". Where brochures and data include information not applicable to this contract, the information which is applicable shall be clearly identified for easy reference.

1.4 ELECTRICAL APPARATUS AND WIRING:

- A. Motors: Motors shall conform in all respect to the latest applicable standards of NEMA and IEEE and shall be the type most suitable for the equipment and/or machinery they are to operate. Each motor shall have sufficient capacity to start and operate the equipment and/or machinery it drives without its required brake horsepower exceeding the motor nameplate rating at the specified speed or at any speed and load which may be obtained by the drive actually furnished. Motor horsepowers scheduled on the drawings are estimated as a guide to approximate requirements; however, actual motors furnished shall be selected to comply with the requirements of this paragraph.
- B. Except as may be otherwise specified, each motor furnished hereunder shall be complete with a motor starter of proper type for the intended service. Motor starter shall comply with the requirements of NEMA and IEEE, and shall be equipped with proper thermal overload elements. Unless stipulated otherwise hereinafter and/or on the mechanical drawings, or required by the specific requirements of the motor and drive, starters shall comply with the following:
 1. Starters for motors 1/2 hp and larger and/or motors controlled by automatic devices shall be of the fully enclosed, general purpose surface mounting, full voltage, across-the-line, magnetically operated type.
 2. Where the motor is automatically controlled, the starter shall be provided with a three-position "Hand-Off-Automatic" switch mounted in the case.
 3. Where the motor is manually controlled from a remote location, a magnetic starter and flush mounted remote push-button station with pilot light shall be provided.
 4. Where the motor is manually controlled at the starter, a "Start-Stop" push-button shall be provided in the cover of magnetic starters.
 5. Where "reduced voltage" starters are indicated they shall be of the type specified hereinafter or indicated on the drawings.
- C. Installation:
 1. Unless expressly stipulated otherwise, electrical apparatus (motors, electric space heating equipment and/or other electrical equipment) furnished under "Mechanical" shall be installed under "Mechanical".
 2. All power wiring for electrical apparatus furnished under "Mechanical", including necessary circuit breakers or fused disconnect switches not furnished integral with the equipment, will be provided under "Electrical".
 3. Starters, controllers and/or other control devices furnished under "Mechanical" for field installation in power wiring shall be installed under "Electrical".

4. All inter-control wiring, associated control system wiring and pilot circuit wiring required to accomplish and control sequence specified under "Mechanical" and/or shown on the mechanical drawings shall be provided under "Mechanical".
 - a. Associated control system wiring is defined as that wiring which is necessary to power or control any electrical-pneumatic or other electric control device furnished under "Mechanical".
 - b. Pilot circuit wiring is defined as that wiring which is necessary to power or control any starter and/or other controller furnished under "Mechanical" and interposed in the wiring to the electrical apparatus. For example, the wiring between a remote push-button station and a magnetic motor starter, including wiring through any safety or other auxiliary control devices interposed in such wiring, is considered pilot circuit wiring.
5. Any remote push-button stations and/or control devices provided under "Mechanical" and not interposed in the power wiring shall be installed under "Mechanical".
6. Conduit and outlet boxes for wiring provided under "Mechanical" will be provided under "Electrical" only when specifically indicated on the electrical drawings. Conduit and outlet boxes not so indicated on the electrical drawings shall be provided under "Mechanical".
7. Any wiring, conduit and outlet boxes provided under "Mechanical" shall be in strict accordance with all applicable requirements of "Electrical", provided however:
 - a. Line voltage and exposed wiring shall be run in conduit;
 - b. No splices will be allowed except at junction boxes and control centers;
 - c. No two wires of the same color shall be run in one conduit unless all wires of the same color are properly tagged at both ends and any splice points.

1.5 BELT DRIVES:

- A. Each motor driven machine not directly connected to its driving motor shall be equipped with a V-belt drive of rating as recommended by the manufacturer for the service. For variable speed drives, the horsepower rating shall be based on the specified mid-position operating conditions.
- B. Variable and adjustable pitch sheaves shall, unless otherwise specified, be selected so that the required RPM will be obtained with the sheave set approximately in mid-position.
- C. Each belt drive shall be provided with an approved guard.

1.6 MISCELLANEOUS PROVISIONS:

- A. Definition: Unless otherwise defined or modified on the drawings, the word "exposed" shall be interpreted to mean all piping, ducts, equipment, and similar work which is not concealed within the building walls, floors, or ceilings or above suspended ceilings or behind furring or buried in the ground.
- B. Certification: When the work of this Division 23 is completely balanced and in permanent operating condition, the Contractor shall submit certification in six (6) copies to the Engineer that the system is installed in accordance with drawings, specifications and manufacturer's recommendations and that safety and operating controls are functioning properly.

- - END OF SECTION 230500 - -

SECTION 230508 - SEISMIC PROTECTION FOR MECHANICAL PIPING & EQUIPMENT**PART 1 GENERAL**

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 010000 Specification Sections, apply to this section.

1.01 GENERAL:

- A. The contractor shall install all mechanical equipment in accordance with the design detail provided by a seismic engineer. The engineer shall be registered, shall be experienced in the design of site-specific seismic protection of mechanical equipment and piping and shall be employed by and responsible to the appropriate mechanical (HVAC or plumbing) sub-contractor.
- B. Where it is determined that seismic protection is not required, provide a letter stating the installation does not require any seismic protection.

- END OF SECTION 230508 -

SECTION 230513 - START-UP OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 ADJUSTMENTS AND TESTS:

- A. All piping systems for which specific tests have not been specified shall be tested hydrostatically, or by other procedure mutually agreed upon and approved, and proved mechanically sound and free from leaks. Test pressure for such tests shall be 150% of the design working pressure of the line, but in no case less than 125 psig.
- B. Balance all water circulating systems so that quantities circulated will be as specified.
- C. Adjust and balance all duct systems so that air quantities at all inlets and outlets are as indicated and so that air distribution over entire cross sectional areas of conditioned spaces are draft free.
- D. Permanently mark all dampers and adjusting devices so that they can be restored if disturbed at any time.
- E. Adjust all equipment to perform as specified and as required to give satisfactory results.
- F. Upon completion of construction and testing, properly clean all cleanable type filters and leave in as new condition. Replace all throwaway filters with new, previously unpackaged filters.
- G. Contractor shall provide all instruments and facilities for performing all required tests in an approved manner.
- H. Comply with start-up requirements as stated in individual equipment specifications, (installation and/or operations and maintenance manuals). This includes, but is not limited to, chillers, air handling units, packaged roof top units, fans, pumps, etc.

1.2 INSTRUCTIONS:

- A. Provide and mount on the equipment or storage room wall a suitable #16 gauge metal cabinet with hinged cover and push button latch. Cabinet shall be designed for permanent storage of one (1) complete set of all required installation, operating and maintenance instructions which shall be enclosed therein by the Contractor. Cabinet shall be finished with a hammered gray baked-on enamel.

- - END OF SECTION 230513 - -

SECTION 230549 - VIBRATION AND NOISE CONTROL

PART 1 - GENERAL

1.1 SCOPE:

- A. Unless otherwise specified or noted on drawings, all mechanical equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflection. Deflections shall be as noted on drawings or as specified hereinafter.

1.2 MANUFACTURER:

- A. Vibration and noise control equipment specified hereinafter shall be as manufactured by Mason Industries, Inc. Equal products of Korfund, Peabody or Vibration Mountings & Controls will be acceptable.

PART 2 - PRODUCTS

2.1 VIBRATION MOUNTINGS:

- A. Type A: Double deflection neoprene mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. Bolt holes shall be provided for these areas where bolting is required. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang. Mountings shall be Type ND or rails Type DNR as manufactured by Mason Industries, Inc. or equal.
- B. Type B: Spring type isolators shall be free-standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8" of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
- C. Type C: Equipment with operating weight different from the installed weight, such as chillers, boilers, etc., and equipment exposed to the wind, such as cooling towers, shall be mounted on spring mountings as described for Type B, but a housing shall be used that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection, and cooling tower mounts shall be located between the supporting steel and roof or the grillage and dunnage as shown on the drawings. The installed and operating heights shall be the same. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operations. Mountings used out-of-doors shall be hot dipped galvanized. Mountings shall be Type SLR as manufactured by Mason Industries, Inc.

2.2 VIBRATION HANGERS:

- A. Type D: Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include a scale drawing of the hanger showing the 30 degree capability. Hangers shall be Type 30N as manufactured by Mason Industries, Inc.
- B. Type E: Vibration hangers shall be as described for Type D, but they shall be precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a scale drawing of the hanger showing the 30 degree capability. Hangers shall be Type PC30N as manufactured by Mason Industries, Inc.
- C. Type F: Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 20 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be provided with an eye bolt on the spring end and provision to attach the housing to the flat iron duct straps. Submittals shall include a scale drawing of the hanger showing the 30 degree capability. Hangers shall be Type W30 as manufactured by Mason Industries, Inc.

2.3 HORIZONTAL THRUST RESTRAINTS:

- A. Type X: Where indicated, handling equipment shall be protected against excessive displacement which might result from high air thrusts in relation to the equipment weight. The horizontal thrust restraint shall consist of a spring element in series with a neoprene pad as described in Specification B with the same deflection as specified for the mountings or hangers. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with one rod and angle bracket for attachment to both the equipment and ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit. Horizontal thrust restraints shall be Type WB as manufactured by Mason Industries, Inc.

2.4 BASES:

- A. Type G: Vibration isolator manufacturer shall furnish integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be 'T' or 'L' shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth

need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1". Bases shall be Type WF as manufactured by Mason Industries, Inc.

- B. Type H: Vibration isolator manufacturer shall provide steel members welded to height-saving brackets to cradle machines having legs or bases that do not require a complete supplementary base. Members shall be sufficiently rigid to prevent strains in the equipment. Inverted saddles shall be Type ICS as manufactured by Mason Industries, Inc.
- C. Type J: Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6". Forms shall include minimum concrete reinforcement consisting of 1/2" bars or angles welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom, or additional steel as is required by the structural conditions. Forms shall be furnished with steel members to hold anchor-bolt sleeves when the anchor bolts fall in concrete locations. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Bases shall be Type K as manufactured by Mason Industries, Inc.

2.5 CURB-MOUNTED BASES:

- A. Type Y: Where indicated, curb-mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom member to provide water runoff independent of the seal. The aluminum members shall house cadmium plated springs having a 1" minimum deflection with 50% additional travel to solid. Spring diameters shall be no less than 0.8" of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible ductlike EPDM connection joining the outside perimeter of the aluminum members. Foam or other contact seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum. Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. Curb-mounted bases shall be Type CMAB as manufactured by Mason Industries, Inc.
- B. Type Z:
 - 1. Where indicated, curb-mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment. The extruded aluminum top and bottom members shall contain cadmium plated springs having a 1" minimum deflection with 50% additional travel to solid. Spring diameters shall be no less than 0.8" of the spring height at rated load. Springs shall be located at maximum intervals of 2' and shall be so selected that the total force of all the springs in the base system amounts to no more than 20% of the total weight of the mounted unit. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds.

2. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible ductlike neoprene connection joining the outside perimeter of the aluminum members. Foam or other contact seals are unacceptable at the spring cavity closure.
3. Eighty percent (80%) of the weight of the equipment shall be taken by four (4) springs having a minimum deflection of 3-1/2" that are seated on steel bridging members that pass over the top of the unit. These springs shall be used in series with neoprene pads and shall have all the characteristics of the springs described above except that they shall be hot-dipped galvanized rather than cadmium plated. Attachment to the unit shall be by leans of 1" threaded rods attached to the unit's lifting lugs by means of clevises. The crossmembers shall be supported by four (4) columns, which in turn are resting on load distributing beams that run the length of the roof curb on either side of the unit. The beams shall be cemented to continuous 1/4" thick waffle neoprene pads so as not to cut the roof membrane.
4. Submittals shall include all spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. The sealing curb shall be Type CMAB and the 3-1/2" deflection springs Type IM, all as manufactured by Mason Industries, Inc. The vibration vendor shall furnish the steel structure with calculations showing that the roof supported beams will reflect no more than 1/360th of the span if supported at the ends as simple members with similar maximum deflection limitations for the upper bridging members. All structural steel members shall be primed with red lead paint prior to shipment.

2.6 FLEXIBLE PIPE CONNECTIONS:

A. Type K:

1. Flexible neoprene connectors shall be provided on equipment as indicated or specified. They shall be manufactured of multiple plies of nylon tire cord fabric and neoprene both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement. Straight connectors shall have two (2) spheres. Connectors up to and including 1-1/2" diameter may have threaded ends. Connectors 2" and larger shall be manufactured with floating galvanized flanges recessed to lock the connector's raised face neoprene flanges. Hoses shall be installed on the equipment side of the shutoff valves.
2. Connectors shall be rated a minimum of 150 psi at 220°F. Flanged equipment shall be directly connected to neoprene elbows in the size range 2-1/2" through 12" if the piping makes a 90 degree turn at the equipment. All straight-through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer to prevent additional elongation under pressure. 12" and larger sizes operating above 100 psi shall employ control cables with end fittings isolated by means of 1/2" thick bridge bearing neoprene washer bushings designed for a maximum of 100 psi.
3. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 db in vibration accelerations and 10 db in sound pressure levels at typical blade passage frequencies.

- 4. Elbows shall be Mason-Flex Type MFNEC, straight connectors Mason-Flex Type MFTFU or MFTNC, and control cable assemblies Type ACC, all as manufactured by Mason Industries, Inc.
- B. Type L: Flexible stainless steel hoses shall be provided where indicated or specified.
 - 1. Hoses shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Lengths shall be as tabulated:

<u>Flanged</u>		<u>Male Nipples</u>	
3 x 14	10 x 26	1/2 x 9	1-1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2-1/2 x 18
6 x 20	16 x 32	1-1/4 x 12	
8 x 22			
 - 2. Hoses shall be installed on the equipment side of the shutoff valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be Type BSS as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 **INSTALLATION:**

- A. All noise and vibration control equipment shall be installed in strict accordance with manufacturer's recommendations and instructions.

- - END OF SECTION 230549 - -

SECTION 230593 - TESTING AND BALANCING AIR SYSTEMS

PART 1 GENERAL

1.1 SCOPE:

- A. The Mechanical Contractor shall employ a testing and balancing firm specializing in total system testing and balancing. The balancing firm shall provide all labor, equipment, engineering and test equipment required to test, adjust, and balance all air, fluid, mechanical, control, and electrical systems associated with HVAC systems to optimum performance.
- B. Any corrective action shall be completed by the Mechanical Contractor and the systems re-tested

1.2 SYSTEM PERFORMANCE REQUIREMENTS

- A. General, Mechanical and Electrical Contractors shall coordinate and cooperate with the TAB contractors as necessary to allow them to perform work.
- B. Items such as start-up, initial testing, cleaning, calibration of controls, electrical testing, etc., are to be completed prior to the commencement of TAB work.

1.3 SUBMITTALS

- A. Procedure Submittal: Prior to commencing work, submit, for approval, a written procedure of how balance will be performed and a description and manufacturer's name of equipment and instruments to be used. The submittal shall include, but not necessarily be limited to the following:
 - 1. List of preliminary checks to be performed at the job site such as confirmation that manual volume dampers are present, filters are installed, frequency drive units operational, location of control sensors, etc.
 - 2. Identify how the air outlets will be measured and the type of instruments to be used.
 - 3. Locations of pitot traverses and the type of instruments to be used.
 - 4. Modes of operation that the system will be placed in during balancing and testing, i.e., full cooling and heating, maximum and minimum outside air flows, maximum and minimum sash positions for hoods, toilet fans on or off, etc.
 - 5. Operating static pressures for terminal devices and pressure sensors for controlled devices.
 - 6. Method of adjusting outside and return air quantities at air handling units.
 - 7. Initial test procedures for preliminary balance.
 - 8. Final test procedures.
 - 9. List of deficiencies in mechanical system that could hinder the balance work such as missing or leaky dampers, incomplete systems, inadequate fans, etc.
 - 10. Sample of data sheets and test forms to be used in final report.
 - 11. Identification and manufacturer's name of equipment to be used on project and proof of last calibration on each piece.
- B. Progress Report(s) – Report, in writing, any deficiencies or problems with air or water systems that have affected balance work. Include items that affect system performance such as broken thermostats, damaged ductwork, excessive noise, etc.

1.4 QUALITY ASSURANCE

- A. Test, adjust, and balance systems in accordance with ASHRAE Applications Handbook. For NEBB certification, comply with "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." For AABC certification, comply with "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."
- B. TAB contractors shall present to the Owner, proof of current equipment certification approved by National Institute of Standards and Technology.
- C. Testing Agency Qualifications: Agency shall be NEBB or AABC certified in testing and balancing disciplines required for this project. Work shall be performed under direct supervision of a NEBB, or AABC certified supervisor.

1.5 WARRANTY

- A. Guarantee of Work: TAB contractor shall guarantee the balancing for a period of 90 days from date of acceptance of final report. During this period, the TAB contractor shall make personnel available at no cost to the Owner to verify measurements and/or correct deficiencies in the balance. During this period, emergency adjustments shall not void this warranty.

PART 2 - PRODUCTS AND EXECUTION

2.1 BALANCING CONTRACT: Shall incorporate the following:

- A. Adjust and balance the complete mechanical system, including exhaust fans.
- B. Upon completion of the air handling systems, the Contractor shall have an air balancing firm perform the following tests and compile the following information for each item of equipment and submit four (4) bound copies of this information to the Architect for approval.
- C. Install, at each piece of mechanical equipment, a "Data Register" showing all significant operating temperatures, pressures, amperes, voltage, brake horsepower, etc.. "Data Register" to be enclosed in a vinyl holder securely attached to the equipment or wall in immediate area after balance reports have been accepted.
- D. All test equipment will be furnished by the Balancing Contractor and will remain his property. All instruments will have been calibrated recently.
- E. The Balancing Firm shall warrant solely that the system will be set to within 10% of the values as established by the plans and specifications, and also adjust to minimize drafts in all areas.
- F. Any changes that are required for the final balancing results as determined by the Balancing Contractor will be provided by the respective Contractors who are to supply and install such equipment under their contractual obligations. Such changes may encompass, but are not necessarily restricted to, the changing of pulleys, belts, dampers, or adding dampers or access panels.

2.2 BALANCING PROCEDURE:

- A. Before starting air balance, check the following items:
 - 1. Check air filters to be sure they are clean and in position.
 - 2. Check for proper belt tension and alignment.
 - 3. Check fan and motor lubrication.
 - 4. Check motor overload protectors or heaters for proper size.
 - 5. Check for proper rotation.

- B. Measure supply air volumes by means of the duct traverse method, taking a minimum of sixteen (16) readings. Seal duct access holes in metal ducts with metal snap-in-plugs. The use of duct tape to seal access holes will not be permitted.
- C. Adjust balancing dampers for required branch duct air quantities. Dampers shall be permanently marked after air balance is complete.
- D. Adjust grilles and diffusers to within 10% of individual requirements specified, and also adjust so as to minimize drafts in all areas.
- E. The total air delivery in any particular fan system shall be obtained by adjustment of the particular fan speed.
- F. The drive motor of each fan shall not be loaded over the corrected full load amperage rating of the motor involved.
- G. All duct systems are to be balanced for lowest static pressure and lowest fan speed possible to deliver required air quantity.
- H. Unless otherwise noted, adjust quantity of return air from space to pass 90% of air supplied to space.
- I. Where splitter and volume dampers have been provided for balancing of air in ducts, balancing shall be done with register and diffuser volume dampers as fully open as possible.
- J. Do not operate fans during times when construction process or clearing would allow dirt or rubbish to accumulate in the system.

2.3 CERTIFICATION:

- A. Furnish to the Architect/Engineer two (2) copies of the following data, signed by an authorized representative.
 - 1. Room
 - 2. Supply or Return Size
 - 3. Design CFM
 - 4. Measured CFM
 - 5. Percent of Design CFM.

2.4 FINAL AIR BALANCE:

- A. Perform final air balance after building is occupied. On final air balance adjust air quantities as required to maintain space temperatures in building at 78°F plus or minus 2°. Submit data sheets on recorded temperatures. Indicate time of day and outdoor temperature on data sheets.

-- END OF SECTION 230593 --

SECTION 230700 - THERMAL AND ACOUSTICAL INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Attention is directed to Sections 220719 and 23071.
- B. The work of this Section consists of insulation of all hot and cold surfaces subject to heat loss, heat gain or condensation.

PART 2 - MATERIALS

2.1 MANUFACTURER:

- A. Products of CertainTeed, Owens-Corning or Johns-Manville, specified hereinafter are acceptable.

2.2 FIRE AND SMOKE HAZARD RATINGS:

- A. All insulation, unless specifically excepted hereinafter, shall have composite (insulation, jacket or facing, and adhesive used to adhere the facing of jacket to the insulation) fire and smoke hazard ratings as tested by procedure in UL 723 and ASTM E-84, not exceeding:

Flame Spread	25
Smoke Developed	50
Fuel Contribution	50
- B. Accessories, such as adhesives, mastics, cements and tapes for fittings shall have the same component ratings as listed above.
- C. All products or their shipping cartons shall bear a label indicating that flame and smoke ratings do not exceed above requirements.
- D. Any treatment of jackets or facings to impart flame-and-smoke safety shall be permanent. Use of water-soluble treatments is prohibited.
- E. The Contractor shall certify in writing, prior to installation, that all products to be used will meet the above criteria.

PART 3 - EXECUTION

3.1 APPLICATION - GENERAL:

- A. Execution of the work shall be by the insulation manufacturer or contractors specializing in the installation of insulation. The installing contractor shall submit their qualifications and certifications with the insulation submittals for the Engineer to review.
- B. Insulation shall not be applied until equipment, piping, and ducts have been inspected and released for application.
- C. Insulation shall be applied on clean, dry surfaces.
- D. All insulation shall be continuous through wall and ceiling openings and sleeves.
- E. Insulation on all cold surfaces where vapor barrier jackets are used, shall be applied with a continuous unbroken vapor seal. Hangers, supports, anchors, or other items that are secured directly to cold surfaces shall be insulated and vapor-sealed to prevent condensation.
- F. Any insulation that becomes wet shall be removed, disposed, and replaced.

- G. Insulation shall be stored on the job site in a manner as to protect it from dust, debris, damage, etc.

-- END OF SECTION 230700 --

SECTION 230713 - DUCT INSULATION**PART 1 - GENERAL****1.1 SCOPE:**

- A. This specification defines the materials and methods of the duct system insulation. Attention is directed to Section 230700 for General Insulation requirements.

1.2 DEFINITIONS:

- A. "Concealed ductwork" is defined to be that portion of a duct system that is installed within ceiling spaces, building chases or in architecturally furred-in spaces.

PART 2 - PRODUCTS**2.1 MATERIALS:**

- A. Fiberglass duct insulation (duct wrap) shall be R-8 (installed), flexible blanket type with factory applied vapor barrier. Vapor barrier shall be minimum 0.7 mil thick aluminum foil reinforced with fiberglass yarn mesh and laminated to 40-lb. chemically treated fire resistant Kraft (FRK).
- B. All insulation shall have a composite (insulation, jacket and adhesive used to adhere the jacket to the insulation) fire and smoke hazard rating, as tested by procedure in UL 723 and ASTM E 84, not exceeding:

Flame Spread	25
Smoke Developed	50
Fuel Contribution	50
- C. Accessories, such as adhesives, mastics, cements and tapes for seams, joints and fittings, shall have the same rating as listed herein.

PART 3 - EXECUTION**3.1 INSTALLATION:**

- A. All supply, return, exhaust and outside air ductwork shall be insulated.
- B. Duct wrap shall be applied with edges tightly butted and secured with outward clinch staples, 2-inches on center. All joints and seams shall be sealed with glassfab and mastic. On ducts over 24" wide or high, insulation shall be applied over pins welded or cemented to the ducts with all joints sealed with glassfab and mastic. Standing duct braces and other duct projections shall be insulated.
- C. Insulation shall be applied on clean, dry surfaces after inspection, and released for insulation application.
- D. All insulation shall be continuous through wall and ceiling openings and sleeves.
- E. Insulation on all cold surfaces where vapor barrier jackets are used shall be applied with a continuous unbroken vapor seal. Hangers, supports, anchors, or other items that are secured directly to cold surfaces must be insulated and vapor sealed to prevent condensation.

- F. Insulation shall be protected from physical damage at points of support where the insulation must carry the load imposed by the support. Coordinate this requirement with the installation of hangers and supports.

-- END OF SECTION 230713 --

SECTION 233100 - AIR DISTRIBUTION SYSTEM**PART 1 - GENERAL****1.1 SCOPE:**

- A. All ductwork shall be galvanized steel.

1.2 SMACNA GUIDELINES AND CODES:

- A. Complete systems of ductwork shall be fabricated and installed in accordance with the recommended and standard practices contained in the latest edition of the SMACNA "Low Pressure Duct Construction Standard" as published by the Sheetmetal and Air Conditioning Contractors National Association, Inc., or the ASHRAE Guide, Equipment Volume, Chapter 1, "Duct Construction", as published by the American Society of Heating, Refrigeration and Air-Conditioning Engineers.
- B. Comply with International Mechanical Code, ASHRAE Guide, and local codes.

1.3 QUALITY ASSURANCE

- A. SMACNA Standards:
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards, second edition".
 - 2. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual".
- B. ASHRAE Standards: Comply with ASHRAE Systems and Equipment Handbook.
- C. NFPA Compliance: Comply with NFPA 90A "Standard for the installation of Air Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems".
- D. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.

PART 2 - PRODUCTS**2.1 GENERAL:**

- A. Ductwork: Except as may be specifically noted otherwise on the drawings, ductwork shall be constructed of galvanized steel conforming to ASTM A 527 with a galvanized coating of not less than 1-1/4 ozs. per sq. ft. for both sides. Flexible duct, in lengths not to exceed 5 feet, may be used at diffuser connections provided it is Class 1 complying with UL 181.
- B. Elbows: Radius elbows shall be used generally; however, vaned elbows shall be used where shown on the drawings and/or required to fit restricted spaces. Turning vanes in ductwork 18" or deeper shall be double wall and 1 gage heavier than installed ductwork. Single wall turning vanes gage shall be equal to ductwork. Short radius elbows are prohibited unless authorized by Engineer.
- C. Accessory Materials: Material for bracing angles, hangers and supports, rivets, screws and other fastening details shall be galvanized steel.
- D. Balancing Dampers: Provide factory-fabricated balancing dampers with locking quadrants at all branch take-offs to facilitate balancing.

- E. Air Distribution Devices: Furnish and install exhaust and supply grilles, registers and air diffusers as shown on drawings and as specified herein. All air distribution devices shall be Titus, Metalaire or Price, or approved equal.
 - 1. Sound Power Level: For grilles, registers and diffusers selected it shall be such that the sound level in the occupied area shall comply with the NC occupancy recommendations in the ASHRAE Guide. Selection and sizing of all grilles, registers and diffusers shall conform to the manufacturer's published performance data.
 - 2. Ceiling Supply Air Diffusers: Shall be of design and air pattern indicated on the drawings with volume control key operated from the face of the device. Provide each supply register and diffuser with an air turning device for deflecting air evenly into the throat of the device. All diffusers and registers shall be of aluminum construction, and shall be of the "fabricated" type, not stamped.
 - 3. Return Air Grilles: Shall be of aluminum construction with sponge rubber gasket.
 - 4. All supply air devices shall be complete with opposed blade volume control dampers.
 - 5. All grilles and diffusers shall be fully insulated.
- F. Fire Dampers: Provide UL fire dampers of suitable arrangement at any point of fire-rated wall/ceiling penetration.
- G. Louvers: Wall louvers shall be by Metal Aire, Carnes, Titus, Arrow United, Dowco. Refer to the drawings for louver sizes and performance. All wall louvers shall be provided with aluminum bird screen or insect screen as indicated.
- H. Flexible duct connections shall be provided at inlet and outlet connections to air handlers and fans.
- I. Duct Sealing Requirements: All supply, return and exhaust ductwork shall be Seal Class B unless required by SMACNA to be Seal Class A. Transfer ducts may be Seal Class C.

PART 3 - EXECUTION

3.1 DUCTWORK AND ACCESSORIES:

- A. Ductwork and accessories shall be installed in strict accordance with NFPA 90A and SMACNA LPDCS, and shall be run approximately as indicated on drawings. Provide offsets and other field changes as necessary to suit the size of factory fabricated equipment actually furnished. Such changes shall be designed to minimize losses in pressure and performance due to sudden expansion and contraction. Transitions shall be used in field changes as well as modifications to connecting ducts.
- B. Duct shall be installed so that ductwork shall operate without chatter, vibration and be airtight so that no dust marks from air leaks will show at connections or outlets. All joints shall be sealed with approved duct sealer.
- C. Elbows, vaned elbows, take-offs, branch connections, transitions, duct volume dampers, flexible connections, other fittings and appurtenances shall conform to SMACNA Duct Construction Manual.
- D. Duct Supports:
 - 1. Supports for concealed ducts shall be not less than 1 inch wide, 22 gauge, galvanized strap hangers spaced in accordance with SMACNA Duct Construction Standards. Hangers shall be installed under insulation with penetrations sealed with mastic. Ductwork 24" or wider shall be supported with angle iron held in place by threaded rod

- from structure. Angle iron and rod to comply with SMACNA standards based on size and weight of duct in addition to hanger spacing intervals.
2. Ducts shall be supported and installed so as to be completely free from vibration under all conditions of operation. Supports shall be attached only to structural framing members.
- E. Round ducts shall be tapped into main duct with conical type fittings with volume dampers having a locking quadrant.
- F. Branches and Tee Connections: Provide 45° boot taps for rectangular to rectangular connections. Provide conical taps for round to rectangular and round to round connections. Conical tees shall be acceptable for round to round connections. Saddle taps are prohibited.
- G. Grille and Diffuser Connections: Air extractors and adjustable dampers are included as accessories to be furnished with the air distribution devices.
- H. Volume Dampers: Install all dampers so that they are accessible for adjustment. Extend damper rod beyond insulation and provide locking device. Conspicuously mark damper rod for quick identification.
- I. Broken places in galvanized sheet metal coating made during forming shall be painted with zinc duct primer.
- J. Access Doors: Shall be hinged and latched. Access doors shall provide ready access to operating parts of any kind. Make doors air tight with a neoprene gasket. Insulate doors in insulated ductwork.
- K. Objectionable Noise, Vibration or Breathing of Ducts: Will not be permitted and the Contractor shall see that such objections are eliminated by anchoring and bracing all ductwork securely to building.
- L. Cleaning of Ducts: Before making final connections to air distribution outlets, the Contractor shall operate fans and shall thoroughly clean out the interior surfaces of all ducts.
- M. Flexible Duct Connections: Flexible connections shall be installed between fan units and metal ducts or casings, and shall comply with NFPA No. 90A.
- N. Temporary Closure: At ends of ducts which are not connected to equipment or air devices at the time of installation, provide temporary closure of polyethylene film or similar covering to prevent dust and debris from entering ductwork. Ductwork that is awaiting installation on the job site shall be covered with the same temporary closure.
- O. End runs of ductwork shall not extend more than 2" past last tap.
- P. Slope exhaust duct connected to grilles in high moisture areas (showers, restrooms, pool areas, etc.) back towards grille. Slope shall be minimum 1/8" per foot.

3.2 TESTING:

- A. Operate all fans and demonstrate quiet and vibration-free operation of duct system.
- B. Air Cleaning Devices: Systems shall not be operated during construction.
- C. Leakage Tests: Conduct duct leakage test on all ductwork constructed to 2" pressure class or higher. Refer to plans for ductwork pressure class schedule. Leakage test shall be in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than the maximum permissible leakage for the pressure class as listed on the plans.
- D. Test Failures: Duct systems shall be repaired if test pressure and leakage requirements are not met or if air noise condition is encountered. Repairs and sealing shall be done with sheet metal, tape, sealant, or a combination thereof.

- E. Ductwork pressure tests shall be observed by Architect/Engineer/Owner or their designee prior to installation of insulation. All testing shall be documented and submitted to the Owner.

-- END OF SECTION 233100 --

SECTION 237413 - PACKAGED HEAT PUMPS – ROOFTOP

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Complete year round, all electric heat pump heating and cooling packaged systems suitable for rooftop installation complete with controls, accessories and capacities as indicated on the drawings or specified hereinafter.

PART 2 - PRODUCTS

2.1 HEAT PUMP - ROOF TYPE:

- A. General: Roof type heat pumps shall be designed, constructed, assembled, rated, and tested in accordance with ARI Standard 210 and 360. Units shall be ARI certified. Units shall have capacities to meet the design conditions as indicated. The unit shall be a factory packaged unit as indicated and shall be suitable for mounting on roof of building. The packaged unit shall consist of refrigerant compressor, cooling coil, condenser, fan, filters, heating coil, control wiring and piping, all factory assembled in a weather proof enclosure mounted on a structural steel base ready for field connection to utilities and ducts. The packaged unit shall be sufficiently rigid and shall be arranged to permit handling by a crane boom or other means. Provide the unit with roof curb, flashing, and transition plenum.
- B. Performance Rating: Cooling capacity of unit shall meet the sensible heat requirements and total heat requirements indicated. In selecting unit size, make true allowance for "sensible to total heat ratio" to satisfy required sensible cooling capacity. Submittals shall include catalog selection data which accounts for sensible to total heat ratio, entering air conditions at evaporator and condenser entering air conditions.
- C. Energy Efficiency Ratio and Coefficient of Performance: Units shall produce not less than the EER and COP ratings of the equipment scheduled on the drawings.
- D. Unit Enclosure: Construct enclosure of galvanized steel not less than 20 US gage thickness, with removable gasketed access panels completely weatherized for outside installation, and properly reinforced and braced. Provide panels and access door for inspection and access to all internal parts. Surface of steel parts shall be factory baked enamel finish. Provide enclosure with adequate reinforced points of supports for setting of the units. Joints shall be air and water tight. Provide protective guard for condenser coil.
- E. Unit Compressor: Unit compressor shall be serviceable hermetic complete with service gauge connections for high and low pressures, crankcase heater, internal overload protection and vibration isolation. The unit shall be provided with controls to prevent the compressor from short cycling and to prevent the compressor from restarting for a 5-minute period.
- F. Evaporator and Condenser Coils: Evaporator and condenser coils shall be constructed of copper tubes with mechanically bonded aluminum fins.
- G. Evaporator Fan: Evaporator fan shall be forward curved centrifugal. Fans shall be multi-speed direct or belt driven. For belt driven fans provide an adjustable motor mounting base with locking device and adjustable pitch pulley on the fan motor. Fan and fan motor shall have sealed permanently lubricated bearings and shall be statically balanced.

- H. Condenser Fans: Condenser fans shall be direct driven propeller type with vertical discharge. Motor shall be weatherproof construction and shall be permanently lubricated. Provide discharge air guard.
- I. Supplementary Electric Heaters: Supplementary electric heaters shall be provided integral with the unit and shall be as open coil design. Heater shall be provided with primary over-temperature protection with each heater circuit provided with a fuse of the proper size. In addition provide an interlock with the supply air fan or a differential air pressure control to prevent heater operation unless fan is operational. Heater shall be UL listed.
- J. Roof Curb: Roof curb shall be provided by the unit manufacturer and shall be gasketed and insulated. Roof curb shall be seismically rated and National Roofing Contractor Association approved.
- K. Units shall be provided with throw-away filters which shall be replaced at job completion.
- L. Provide firestat or smoke detector in return, wired to shut down fan in event of high temperature or smoke, complying with NFPA-90A and Standard Mechanical Code.
- M. Manufacturers: Units shall be as manufactured by Trane, Carrier or approved equal.
- N. Warranty: Units shall be guaranteed against defects in workmanship for a period of one (1) year from date of final acceptance, except that compressors shall be guaranteed for a total of five (5) years.

2.2 ROOM THERMOSTAT:

- A. Room thermostat shall be provided for each system and shall be of the programmable electronic type with digital thermometer, Humidity Controller, fan on-auto switch, emergency heat mode, compressor-on light. 7-day programming shall be provided.

-- END OF SECTION 237413 --

SECTION 238100 - SPLIT-SYSTEM HEAT PUMP

PART 1 - GENERAL

1.1 SCOPE:

- A. Outdoor-mounted, air cooled, split system heat pump suitable for mounting at grade or on a rooftop. The heat pump selection shall match up to the associated air handler.
- B. Indoor-mounted or out-door mounted (attic or garage) split system air handler shall be a direct expansion variable speed fan coil or a constant speed fan coil with either 2 or 3 blower speed settings (low, medium, high).
- C. Specific manufacturer's model number scheduled on the drawings will define the capacity and application for the work along with the specified requirements herein.
- D. Products as may be available from Trane, Carrier or approved equal, equivalent to the specified manufacturer's model scheduled and complying with specified requirements herein are acceptable.

1.2 WORKMANSHIP:

- A. Only skilled and experienced workmen shall be utilized for this work. Any work that is not performed in accordance with standard and recommended practices shall be replaced at the expense of the Contractor. Coordinate with all other contractors prior to installing any item of equipment.

1.3 CODES, FEES, ETC.:

- A. Comply with Standard Mechanical Code, ASHRAE Guide and local codes. Apply and obtain all permits and comply with local inspection requirements.

PART 2 – PRODUCTS

2.1 Split system heat pumps shall be manufactured by Trane, Carrier, or approved equal.

2.2 INDOOR SECTION:

- A. The indoor unit shall be constructed of galvanized steel and coated with baked enamel finish. The cabinet shall be insulated with neoprene coated fiberglass. The cabinet panels shall be easily removed for service to all components. The indoor unit shall be complete with direct expansion coil, multi-speed direct or belt drive centrifugal fan and motor and condensate collector, and shall be completely wired to terminal block. The capacity shall be as scheduled on the drawings. The indoor unit shall be provided with filter frame and throw-away filters unless noted otherwise. Filters shall be replaced at job completion.
- B. The electric strip heater shall be a component part of the indoor unit and shall be the KW and electrical characteristics as scheduled on the drawings. Heaters shall be complete with thermal and overload protection, and including a 24-volt control transformer, insulated terminal box and contactor. In addition, the heater shall be provided with an air flow pressure differential control wired through the fan motor control circuit.

- C. Provide smoke detector in return, wired to shut down fan in event of smoke, complying with NFPA-90A and Standard Mechanical Code.

2.3 OUTDOOR SECTION:

- A. The cabinet/casing shall be galvanized steel with baked enamel finish with a protective, dense louvered or louvered coil guard. The compressor shall be a welded hermetic type with internal vibration isolation and external neoprene mounts. The compressor shall have thermal and over-current protection, high pressure cut-out and crankcase heater. Provide a protective, dense coil guard cap.
- B. Condenser fan shall be direct drive with vertical discharge propeller fan and fan/coil guards. Fan motor shall be totally enclosed, permanently lubricated, inherently protected and resiliently mounted. Fan blades shall be both statically and dynamically balanced.
- C. Condenser coil shall be mechanically bonded fin and tube with changeover valve, quick attach refrigerant couplings, gauge taps, filter-drier and refrigerant metering device.
- D. Control shall be factory wired and shall include an anti-recycle timer control, outdoor thermostat, automatic defrost controls, control transformer, compressor contactor, and wiring terminal block with all components enclosed in a weatherproof compartment.
- E. Refrigerant tubing may be pre-insulated and pre-charged type as provided by the unit manufacturer. Where insulation is exposed to the weather, coat with vinyl lacquer two coats minimum.
- G. The outdoor unit shall have seacoast coated coils.

2.4 HEAT PUMP SYSTEM:

- A. The entire heat pump system shall consist of matched components rated in accordance with A.R.I. 240 and shall be UL labeled.

2.5 WARRANTY:

- A. The units shall be warranted for all parts and labor for one (1) year from date of acceptance with an additional extended four (4) years warranty on the compressor. Register warranties with the manufacturer and provide Owner with copies.

2.6 ROOM THERMOSTAT:

- A. Room thermostat shall be provided for each system and shall be of the programmable electronic type with digital thermometer, Humidity Controller, fan on-auto switch, emergency heat mode, compressor-on light. 7-day programming shall be provided unless noted otherwise.

2.7 CONDENSATE DRAIN PIPING:

- A. Piping shall be Schedule 40 PVC (CPVC in plenum rated areas) with solvent cemented joints. Provide P-trap at unit and insulate entire drain line with 5/8" thick foam plastic insulation, or 1" fiberglass with vapor barrier. Slope piping .25" per foot away from unit.

PART 3 - EXECUTION

3.1 HEAT PUMPS:

- A. Heat pumps shall be installed as indicated and as recommended in the manufacturer's installation and operating instructions. If located at grade, outdoor unit shall be mounted on a level concrete pad a minimum of 4" above surrounding grade.

3.2 AIR HANDLERS:

- A. Mount air handler on cork-and-rubber vibration isolators or suspend from building structure with hangers having in-line spring isolators.
- B. Provide an auxiliary drain pan with liquid-tight seams for each air handler.
- C. Auxiliary drain pan shall be fitted with a normally-closed float switch which shall disable the heat pump in the event of high water in the pan, or a 1" PVC pipe to discharge at a conspicuous location acceptable to the Building Official.

3.3 PAINTING:

- A. Equipment and items with a factory applied finish shall have scratched, chips, etc., primed and touched up with paint to match color of equipment and/or items installed.

3.4 CLEANING AND ADJUSTMENTS:

- A. Upon completion of work, clean, oil, and grease all fans, motors, other running equipment and apparatus and make certain that all such apparatus and mechanisms are in proper working order and made ready for tests.

3.5 TESTS:

- A. Balance all supply direct/diffuser systems and provide complete air balance report to Engineer prior to requesting final inspection. Report shall be signed by a principal of the mechanical contracting firm.

3.6 CUTTING OF STRUCTURE:

- A. Where it is required to cut any part of the structure for installation of equipment, the cutting shall be under the direction of the General Contractor.

3.7 ELECTRICAL:

- A. All electrical work and materials shall conform to the requirements of Section 230500.
 - 1. Split-System Heat Pumps (Indoor Unit): Indoor unit and auxiliary strip heater shall be provided and installed by this Section. Indoor unit and strip heater shall be furnished with all operating and safety controls. This Section shall also provide and install all controls, control wiring, conduit, etc., and make connections required for complete installation.
 - 2. Split-System Heat Pump (Outdoor Unit): Outdoor unit shall be provided and installed by this Section. The unit shall be provided with all operating and safety controls, conduit, wire, and shall connect electrically from load side of disconnect to outdoor unit. This Section shall also provide and install all the necessary controls, control wiring and conduit.
 - 3. Power wiring, including service disconnect, is provided under Division 16.

-- END OF SECTION 238100 --

SECTION 260500 - BASIC ELECTRICAL MATERIALS AND METHODS**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, General Conditions of the Contract for Construction, AIA A201, 1997 Edition, apply to work of this Section and all subsequent Division 26 Sections.

1.2 SUMMARY

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in sections of Division 01 through Division 23.
- B. The work covered by this Division of the specifications consists of furnishing all material and labor, equipment and supplies, and performing all operations including cutting, channeling, chasing, excavating and backfilling necessary for the installation of complete wiring systems and electrical equipment, in accordance with this Division of the specifications and the accompanying drawings.
- C. Included are systems for lighting, power, connections to equipment furnished by others, telephone, fire alarm, and others as indicated.
- D. The work shall be coordinated with the work of other trades to insure correct location and installation of the building components and equipment required by all trades for electrical service.
- E. Prior to bidding the work, the Contractor shall examine all sections of the specifications and the complete set of Contract Documents and bring to the attention of the Architect and Engineer any omissions, conflicts, or concerns effecting this Division of the work.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

- A. Execute and inspect all work in accordance with Underwriters Laboratories (UL), and all local and state codes, rules and regulations applicable to the trade affected as a minimum. If the plans and/or specifications call for requirements that exceed these rules and regulations, the more stringent requirement shall be followed. Follow applicable sections and requirements and testing procedures of NFPA, IEEE, NEMA, CBM, ANSI, NECI, ICEA and NETA.
- B. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date of edition is indicated.
- C. All materials and equipment used on this project shall be UL Listed and Labeled for their intended purpose and shall be acceptable to the authority having jurisdiction as suitable for the intended purpose.
- D. After entering into contract, Contractor will be held to complete all work necessary, whether or not indicated on the Contract Documents, to comply with all local and state codes, ordinances, rules and regulations applicable and meet these requirements without additional expense to the Owner.

1.4 PERMITS AND FEES

- A. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.

1.5 TEMPORARY FACILITIES

- A. Light, Heat, Power, Etc.
 - 1. Responsibility for providing temporary electricity, heat and other facilities shall be as specified in Division 01.
- B. Building distribution equipment and devices may only be used with written permission from the Owner. If used for temporary power, the equipment shall be properly maintained and the Contractor shall repair any damage resulting from use. The guarantee period for new equipment shall not begin until the equipment is turned over to the Owner.

1.6 SUBMITTALS

- A. Product Data:
 - 1. Submit for review descriptive data for all products proposed for installation under this specification and other sections of Divisions 26. These submittals should show, as a minimum, the following:
 - a. Manufacturers and complete model and part number.
 - b. Dimensions.
 - c. Complete technical specifications and performance data.
 - d. Any other pertinent information necessary to determine adequacy for the intended application.
 - e. A colored picture for any products of a decorative nature such as lighting fixtures.
 - 2. Submit product data for any equipment added to the scope of this contract through addendum, change order, unit price, etc.
 - 3. Submit samples of equipment when so requested.
 - 4. Submit Certificates of Acceptance from all inspection authorities.
- B. Shop Drawings:
 - 1. Before starting work, prepare and submit to the Engineer for review six sets of all product descriptive data and shop drawings required for the project. Continue to submit for the Engineer's review until a REVIEWED-NO EXCEPTIONS or REVIEWED-EXCEPTIONS NOTED action is received.
 - 2. Recognize the purpose of shop drawings and other submittals is to inform the Engineer about equipment the Contractor proposes to furnish and install. Approved submittals are not change orders and do not give the Contractor authorization to deviate from the specification or the bid price for the project.
 - 3. Submit for approval shop drawings showing complete systems, dimensions, interconnects, control diagrams, electrical subsystems of a special nature or critical to the installation, pertinent data required for installation, and any approved deviations from the original specification. Reference equipment on drawings using identical symbols to those used on the Engineer's drawings and specifications. Indicate in the transmittal that the Contractor has reviewed the submittal.
- C. Field Test Reports:
 - 1. Submit the results of test of independent testing agencies on their standard forms for those tests specified.
 - 2. Submit a written report of results of tests conducted by the Contractor listing the name of the test, the items tested, the results of the final tests, and a statement that the systems tested are in proper working order.
 - 3. Operational tests of all equipment including lighting fixtures, motors, fans, timers, contactors, circuit breakers (limited to switching function only unless otherwise requested), shunt trips, relays, GFI systems, alarms, special systems, and any other equipment or system requested in other sections of Division 26.

1.7 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. If the Contractor wishes to bid an alternate item, a request shall be submitted in writing in accordance with the General Conditions indicating such substitutions within the specified period prior to bid opening. Such requests shall be accompanied by sufficient catalog data upon which a decision may be based. Refer to Division 1 for all required submittal procedures and formats.
- B. The burden of proof that proposed equipment is equal or superior to that specified shall be on the Contractor. Substituted equipment shall only be allowed where specifically listed by written addendum. If substitutions are not granted, the specified materials and equipment shall be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related or affected trades of the accepted substitution and to assume full responsibility for any costs caused as a result of the substitution.

1.8 PRODUCT LISTING

- A. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, sheet metal, steel bar stock, welding rods, solder, fasteners and similar items used in Work, except as otherwise indicated.
- B. For conduit, wire, and fittings, the Contractor shall select a prime and alternate manufacturer from the list of acceptable manufacturers provided in the appropriate sections of this Division. The prime and alternate manufacturers shall be identified in the shop drawings. The Contractor shall make every effort to use the prime manufacturer for the entire project. If products from the prime manufacturer are unavailable, the Contractor shall use the alternate manufacturer with the following provisions.
 - 1. Wire: All wire placed in a single conduit or installed in multiple conduits making up parallel feeders shall be of the same manufacturer.
 - 2. Conduit and Fittings: All conduits and fittings installed exposed within the same room or immediate area shall be of the same manufacturer.
- C. Provide products that are compatible within systems and other connected items.

1.9 NAMEPLATE DATA

- A. Provide equipment having a permanently mounted, operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Install equipment such that nameplate is readily visible.

1.10 QUALITY ASSURANCE

- A. Source Limitations: Obtain all equipment and materials of the same type through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. Except where noted otherwise, equipment and materials shall be new and unused and as specified and shall not be substituted unless authority is obtained from the Architect or Engineer.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Division 1 sections on Transportation & Handling, and Storage & Protection.

- B. Deliver products to project site properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identification; adequately packaged and protected to prevent damage during shipment, storage, and handling.
 - 1. Damaged products shall be promptly removed from the premises and replaced with acceptable products, without cost to the Owner.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.
 - 1. Materials such as light fixtures, lamps, panelboards, etc., shall be stored within a weatherproof building or other approved enclosure.
 - 2. Raceways, underground wiring, and similar materials shall be stacked 8" above ground.
- D. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installation.

1.12 PROJECT CONDITIONS

- A. The Contractor shall visit job site and verify all conditions and dimensions. No extra payment shall be approved for unforeseen items.

1.13 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

1.14 ACCESSIBILITY

- A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final locations with piping, ducts, and equipment of other trades to ensure proper access for all trades. Coordinate locations of concealed equipment; disconnect switches, and enclosure boxes with access panels and doors. Allow adequate space for removal of parts, fuses, lamps, etc. that require replacement or servicing.
- B. Extend all conduits such that junction boxes and pull boxes are in accessible locations.
- C. Install access panels or doors where equipment or boxes are concealed behind finished surfaces.

1.15 ROUGH-IN

- A. Verify final rough-in locations with field measurements and the requirements of the specific equipment to be connected.

- B. Refer to equipment specifications in all other sections for rough-in requirements.

1.16 RECORD DOCUMENTS

- A. Refer to Division 1, section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 1.
- B. During construction, the Contractor shall maintain a set of updated record construction documents at the job site for the singular purpose of recording the above information. All record drawings shall be completed in erasable pencil. These changes shall be updated weekly.
- C. Mark Drawings to indicate revisions to conduit size and location for both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned from column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control systems devices, and any other relevant deviations from the Contract Documents.
- D. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.
- E. Mark light fixture schedule on drawings to indicate manufacturer and complete catalog numbers of installed equipment where approved substitutions have occurred.
- F. Mark all schedules including panelboard schedules, mechanical schedules, and similar equipment schedules on drawings to indicate installed equipment and materials used, and any deviations or revisions to electrical load data and calculations.
- G. Upon project completion, all changes noted in above shall be recorded neatly, with red ink, by the Contractor on an unused set of Contract Documents and submitted to the Architect. This project shall not be considered complete until the updated record documents have been received and reviewed by the Engineer. The reviewed Project Record Documents shall then be returned to the Architect.
- H. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme.
 - 1. Red shall indicate new items and any deviations.
 - 2. Green shall indicate items removed or deleted.
 - 3. Blue shall be used for relevant notes and descriptions.

1.17 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1, section on Project Closeout or Operation and Maintenance Data for procedures and requirements for preparation and submittal of maintenance manuals.
- B. In addition to the information required by Division 1 for Maintenance Data, include the following information:
 - 1. Description of function, normal operating characteristics and limitations, fuse curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, emergency instructions, and summer/winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions, lubrication charts and schedules.
 - 5. Complete list of parts and wiring diagrams.

6. Name, address and telephone numbers of the Contractor, Sub-contractors and local company responsible for maintenance of each system or piece of equipment.
 7. All information shall be permanently bound in a 3-ring binder. The job name & address and Contractor's name & address shall be permanently placed on both the cover and spine of each binder. Dymo-tape is not acceptable.
 8. Copies of all test reports shall be included in the manuals.
- C. This contract will not be considered complete nor will final payment be made until all specified materials, including test reports, have been provided and the Architect/Engineer has reviewed the manual.

1.18 WARRANTIES

- A. Refer to Division 1, section on Warranties and Bonds for Procedures and Submittal Requirements for Warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.
- B. The Contractor shall furnish a written guarantee to the Owner covering a period of one year from the date of final acceptance of the installation. The guarantee shall cover materials and workmanship, and any omission or defects that may arise or be discovered during the period and shall be corrected in a manner that is acceptable to the Owner at no additional expense.
- C. Provide complete warranty information for each item. Information shall include product or equipment description, beginning date of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
 1. Compile and assemble the warranties specified in Division 26 into individual vinyl covered, three ring binders, tabulated and indexed for easy reference.
 2. Post the following warranty information on equipment: Length of warranty, installation date, Manufacturer's and Installer's contact information.

PART 2 – NOT USED

PART 3 – EXECUTION

3.1 ELECTRICAL INSTALLATION

- A. Drawings and specifications are complimentary. Whatever is called for in either is binding as though called for in both.
- B. Drawings are diagrammatic in nature and do not necessarily indicate every required conduit, box, fitting, etc.
- C. Drawings indicate generally the location of equipment and are to be followed as closely as possible. If due to job conditions it is found necessary to change the location of equipment, such changes shall be made without additional cost to the Owner and as approved by the Engineer.
- D. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.
- E. Before beginning any installation work, determine if equipment to be installed will properly fit the intended space and if conduit can be run as contemplated without interferences between systems, structural elements, or the work of other trades.

- F. Coordinate the installation of electrical materials and equipment above and below ceilings with suspension system, light fixtures, and other building components. Ductwork and piping shall not be installed above electrical panelboards, switchboards, motor control centers, or transformers.
 - 1. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, space for mechanical and electric systems within the cavity shall be allocated in the following order:
 - a. Plumbing waste, vent piping and roof drain mains and leaders.
 - b. Supply, return and exhaust ductwork.
 - c. Fire sprinkler mains and leaders.
 - d. Electrical conduit.
 - e. Domestic hot and cold water.
 - f. Pneumatic control piping.
 - g. Fire sprinkler branch piping and sprinkler run-outs.
- G. Verify all dimensions by taking field measurements.
- H. Arrange for chases, slots, and openings in other building components to accommodate electrical installations.
- I. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.
- J. Headroom Maintenance: If mounting height or other location criteria is not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- K. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- L. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- M. Right of Way: Give to raceways and piping systems installed at a required slope.
- N. Contractor is responsible for coordinating and scheduling electrical outages necessary to perform the work. Contractor is responsible for cutover to new systems.

3.2 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint.
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
 - 5. Repair damage to electrical equipment finishes with manufacturer's paint selected to match installed equipment finish.

3.3 CLEANING AND PROTECTION

- A. Refer to Division 1 Section "Project Closeout" or "Final Cleaning" for general requirements regarding final cleaning.
- B. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

- C. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
- D. Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps and ballasts.

3.4 CONSTRUCTION REQUIREMENTS

- A. The Contractor shall maintain and have available at the job site current information on the following at all times:
 - 1. Up to date record drawings.
 - 2. Submittals.
 - 3. Site observation reports with current status of all action items.
 - 4. Test results: including recorded values, procedures, and other findings.
 - 5. Outage information.

-- END OF SECTION 260500--

SECTION 260519 - LOW-VOLTAGE POWER CONDUCTORS AND CABLES**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

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

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field Test Reports: Written reports specified in Part 3.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 – PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Conductors and Cables:
 - a. Alpha Wire Company.
 - b. General Cable Corporation.
 - c. Madison Cable Corporation.
 - d. Rome Cable.
 - e. Southwire Company.
 - f. Triangle Wire & Cable, Inc.
 - 2. Connectors and Splices:
 - a. AFC Cable Systems, Inc.
 - b. AMP Incorporated/Tyco International.
 - c. Hubbell/Burndy.
 - d. Ideal Industries.
 - e. O-Z/Gedney; EGS Electrical Group LLC.
 - f. 3M Company; Electrical Products Division.

2.2 CONDUCTORS AND CABLES

- A. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- B. Conductor Material: Copper complying with NEMA WC 70; solid wire for No. 10 AWG, except for motor circuits, and smaller, stranded for No. 8 AWG and larger and

motor circuits. No conductor smaller than No. 12 AWG shall be installed unless otherwise indicated.

- C. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 70.
- D. Multiconductor Cable: Armored cable, Type AC, Metal-clad cable, Type MC, and Type SO with ground wire.
- E. Conductors and cables shall be new and unused, suitable for the temperature, conditions, and location where installed. Type THHN-THWN conductors and cables shall have a outer nylon jacket conforming to UL 83 and be manufactured to meet the standards of Insulated Cable Engineer's Association (ICEA).
- F. Grounding conductor shall be copper, sized to meet NEC.

2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 – EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance, Below Grade: Type USE, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Types RHW, THW or THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or Type MC.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- H. Cord Drops, Portable Appliance Connections, and Flexible leads to light fixtures, wiring devices and indicated equipment: Type SO, hard service cord.
- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway.
- K. Lighting Flexible Connections: Metal-clad cable, Type MC
 - 1. Maximum of 6 feet length for connecting light fixtures in accessible ceilings to the local junction box.
 - 2. Maximum of 3 feet length for connecting light fixtures in non-accessible ceilings to the local junction box.
 - 3. May not be used for branch circuits, home runs, feeder circuits, or motor feeder circuits.

3.2 INSTALLATION

- A. All conductors shall be installed in a raceway.
- B. Conductors shall not be installed in the raceway until the building is closed-in and dry. Prior to installation, the raceway shall be examined and all dirt and debris shall be removed by the use of swabs, vacuum cleaner, blower, or other devices. Conductors shall not be installed in raceway that has moisture accumulation

- C. Install conductors, cables and connectors in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- D. Coordinate conductor and cable installation work, including electrical raceway and equipment connection work, with other work.
- E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Branch circuit feeders whose length from panel to first outlet exceeds 100 feet for 120 volt circuits or 175 feet for 277 volt circuit shall be No. 10 or larger, as required by NEC.
- H. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- I. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage conductor or raceway.
- J. Pull conductors simultaneously where more than one is being installed in the same raceway.
- K. Parallel conductors shall be cut to the same length and be the same type of wire.
- L. Each branch circuit serving emergency receptacles, multi-outlet assemblies or computers shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit shall only be permitted for non-emergency circuits and where specifically noted.
- M. Support conductors and cables according to Division 26 Section "Hangers and Supports for Electrical Systems".
- N. Seal around cables penetrating fire-rated elements according to Division 26 Section "Through-Penetration Firestopping for Electrical Systems."
- O. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Keep conductor splices to a minimum. Install all conductors continuous from outlet to outlet or terminal to terminal. Splices in conductors, when required, shall be made in hand holes, pull boxes, or junction boxes and shall be in strict accordance with cable manufacturer's recommendations utilizing solder less connectors NEMA/UL approved for the use. Splice only within accessible junction boxes. Splice and tap connectors shall be compatible with conductor material.
- D. All splices in control panels, terminal junction boxes, low voltage control circuits and fire alarm conductors shall be on numbered terminal strip
- E. Use solder less pressure connectors with insulating covers for copper wire splices and taps No. 8 AWG and larger. Use insulated spring wire connectors with plastic caps, for No. 10 AWG and smaller.
- F. Use split bolt connectors for copper wire splices and taps, No. 6 AWG through No. 1 AWG. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

- G. Use copper compression connectors for copper wire splices and taps, No. 1/0 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor.
- H. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors larger than No. 10 AWG cabled to individual circuits. Make terminations such that no bare conductor is exposed.
- I. Thoroughly tape the ends of spare wires in boxes and cabinets.
- J. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches of slack and shall be neatly curled into the box before installation of the device and cover.
- K. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to individual ground terminal of devices.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
 - 3. Test shall be made on all feeders regardless of size and on all branch circuits with No. 4 AWG and larger conductors.
- B. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

-- END OF SECTION 260519 --

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.
- B. The service entrance or separately derived system neutral, non-current carrying metallic parts, raceways, and enclosures shall be grounded.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field Test Reports: Written reports specified in Part 3.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 – PRODUCTS**2.1 CONDUCTORS**

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Equipment Grounding Conductors: Insulated with green-colored insulation.
- C. Grounding Electrode Conductors: Stranded cable.
- D. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
- E. Equipment Enclosure Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 3. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- F. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts. Heavy-duty, High-conductivity-plated units listed for the application.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type with copper wall thickness not less than 0.013 inch; 3/4 inch diameter by 10 feet in length.

PART 3 – EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
 - 1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone and similar materials.
- B. Underground Grounding Conductors in Contact with Soil: Install bare copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus (If indicated on drawings): Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors and as otherwise indicated.
 - 3. Connections to Ground Rods: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install insulated equipment grounding conductors terminated at each end on a grounding lug, bus or bushing with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Single-phase motor and appliance branch circuits.
 - 3. Three-phase motor and appliance branch circuits.
 - 4. Flexible raceway runs.
 - 5. Armored and metal-clad cable runs.

- C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Intersystem bonding termination shall be provided and shall include provisions for connecting at least three grounding or bonding conductors required for communications systems with a minimum 6 AWG copper conductor and located at one of the following locations:
 - 1. Meter socket enclosure.
 - 2. Service equipment enclosure.
 - 3. Grounding electrode conductor.
- F. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor

- on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- F. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 25 feet of bare copper conductor sized as indicated on drawings but not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.4 CONNECTIONS

- A. Coordinate with utility transformers. Provide and install materials per utility standards.
- B. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods in direct contact will be galvanized compatible:
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanized series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals and inert material to prevent future penetration of moisture to contact surfaces.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- D. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- F. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- G. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at

entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or ground buses, insulate entire area of connection and seal against moisture penetration.
- I. For below grade connections, provide exothermic-welded type of connectors or compression type connectors designed for this special purpose.
- J. Above ground connectors shall be bronze. To connect copper or copperweld conductor to pad type terminal, use bolted or compression. Use grounding terminals on equipment where provided. Use the bolted type for connecting to steel structures and equipment.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - c. Ground resistance shall not exceed 5 ohms.
- B. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

-- END OF SECTION 260526 --

SECTION 260528 - THROUGH-PENETRATION FIRESTOPPING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes through-penetration firestop systems for electrical equipment and penetrations through the following fire-resistance rated assemblies, including both blank openings and openings containing penetrating items such as conduits, cabling, cable trays and bus duct:
 - 1. Floor-ceiling assemblies.
 - 2. Roof-ceiling assemblies.
 - 3. Walls and partitions.
 - 4. Smoke barriers.
 - 5. Construction enclosing compartmentalized areas.

1.3 PERFORMANCE CRITERIA

A. FIRE TEST REQUIREMENTS

- 1. ASTM E-814 & ANSI/ UL1479, “Fire Tests of Through Penetration Fire Stops”.
- 2. ASTM E-119 & ANSI/ UL263, “Fire Tests of Building Construction and Materials”.
- 3. ASTM E-84 & ANSI/ UL723, “Surface Burning Characteristics of Building Materials”.

B. REFERENCES

- 1. Underwriters Laboratories (UL) of Northbrook, IL “Fire Resistance Directory”.
 - a. Through Penetration Firestop Systems (XHEZ)
 - b. Fill, Void or Cavity Materials (XHHW)
 - c. Firestop Devices (XHJI)
 - d. Forming Materials (XHKU)
- 2. All major building codes:
 - a. Uniform Building Code published by ICBO
 - b. Standard Building Code published by SBCCI.
 - c. National Building Code published by BOCA.
 - d. International Building Code published by ICC.
- 3. NFPA 101: Life Safety Code.
- 4. NFPA 70: National Electrical Code.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide products that upon curing do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
- B. Openings within walls and floors designed to accommodate cabling systems subjected to frequent cable changes shall be provided with re-enterable products specifically designed for retrofit.
- C. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur.

- D. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with re-enterrable products specifically designed for retrofit.
- E. Provide through-penetration firestop systems subjected to an air leakage test conducted in accordance with the Standards, ANSI/ UL1479 for penetration firestop systems, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the firestop system to restrict the movement of smoke.
- F. Provide T-Rating Collar Devices tested in accordance with ASTM E-814 or ANSI/UL1479 for metallic pipe penetrations requiring T-Ratings per the applicable building code.

1.5 SUBMITTALS

- A. Product Data: For each type of through-penetration firestop system product indicated.
- B. System Drawings: Submit documentation from a qualified third-party testing agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
- C. Product Certificates: Certificate of conformance signed by manufacturers of through-penetration firestop system products certifying that products comply with requirements.

1.6 QUALITY ASSURANCE

- A. Provide through-penetration firestop systems that comply with the following requirements and those specified in “Performance Criteria” Article:
- B. Through-penetration firestop system products bear classification marking of qualified testing and inspection agency.
- C. Installer Qualifications: Engage an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products per specified requirements. A manufacturer’s willingness to sell its through-penetration firestop system products to Contractor or to an installer engaged by Contractor does not in itself confer qualifications on buyer.
- D. Source Limitations: Obtain through-penetration firestop systems for each type of penetration and construction condition indicated from a single manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturer’s labels identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency’s classification marking; and mixing instructions for multicomponent materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants or other causes.

1.8 PROJECT CONDITIONS

- A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- B. Do not install through-penetration firestop systems when substrates are wet due to rain, frost, condensation, or other causes.
- C. Do not use materials that contain flammable solvents.

- D. Do not install water-based or products that are conductive when wet in contact with energized electrical conductors. Exercise care when energizing penetrants.

1.9 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes or cut openings to accommodate through-penetration firestop systems.
- C. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

PART 2 – PRODUCTS

2.1 FIRESTOPPING, GENERAL

- A. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- B. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

2.2 MANUFACTURERS

- A. Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers:
 - 1. Dow-Corning.
 - 2. Hilti, Inc.
 - 3. Specified Technologies, Inc. (STI).
 - 4. 3M; Fire Protection Products Division.

2.3 MATERIALS

- A. General: Use only through-penetration firestop system products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
- B. Latex Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture.
- C. Firestop Devices: Factory-assembled steel collars lined with intumescent material sized to fit specific outside diameter of penetrating item.
- D. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds.
- E. Firestop Putty Pads: Intumescent, non-hardening putty pads to be installed on metallic and nonmetallic electrical switch and receptacle boxes to reduce horizontal separation between boxes to less than 24”.
- F. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film.

- G. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating contained in a flame retardant poly bag.
- H. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar.
- I. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surface (nonsag).
- J. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- K. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil.
- L. Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket.
- M. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves.
- N. Fire-Rated T Rating Collar Device: Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General Requirements: Install through-penetration firestop systems in accordance with “Performance Criteria” Article and in accordance with the conditions of testing and classification as specified in the published design.
- B. Manufacturer’s Instructions: Comply with manufacturer’s instructions for installation of through-penetration firestop systems products.
- C. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.
- D. Protect materials from damage on surfaces subjected to traffic.

3.3 FIELD QUALITY CONTROL

- A. Keep areas of work accessible until inspection by authorities having jurisdiction.
- B. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.4 ADJUSTING AND CLEANING

- A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed openings to be free of excess through-penetration firestop system materials and soiling as work progresses.

-- END OF SECTION 260528 --

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For each type and size of electrical support component used.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is qualified by having the necessary experience, staff and training to install manufacturer's products per specified requirements.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Slotted Support Systems:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.

- d. Thomas & Betts Corporation.
- e. Unistrut; Tyco International, Ltd.
2. Mechanical-Expansion Anchors:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Hilti Inc.
 - c. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - d. MKT Fastening, LLC.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 1. Coating for Outdoors or in Damp Locations: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 2. Coating for Indoor Dry Locations: Zinc or equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.
 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Raceway and Cable Support Devices: Steel hangers, clamps, wall brackets, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushings assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- E. Pipe Sleeve shall be either Schedule 40 galvanized steel pipe or EMT or rigid conduit.
- F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable or ductile iron with hot dip galvanized finish.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated carbon steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 5. Hanger Rods: Threaded steel.

PART 3 – EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
 - 1. Use No. 9 ceiling wire to support individual conduits up to 3/4 inch. Use of ceiling support wires is unacceptable.
 - 2. Arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 - 3. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements in accordance with Division 26, Section “Vibration and Seismic Controls for Electrical Systems.”

- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. In open overhead spaces, support metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations as required. Where sleeves through floors are installed, extend above finished floor. For sleeves through fire-rated wall or floor construction, apply UL-Listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 4000-psi, comprehensive strength concrete with normal weight aggregate that conforms to ASTM C 150. Concrete materials, reinforcement, and placement requirements are as follows:
 - 1. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad. Paint top, chamfered areas and floor area 4 inches around sides with black paint. Paint sides yellow. Paint with concrete paint to match existing facility standard. Verify paint type with Owner.
 - 2. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
 - 3. Place concrete and allow to cure before installation of units
- C. Anchor equipment to concrete base according to equipment manufacturer's written instructions
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

- B. Galvanized Surfaces: Clean bolted connections and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

-- END OF SECTION 260529 --

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.
 - 2. Division 26 Section "Through-Penetration Firestopping for Electrical Systems" for firestopping materials and installations at penetrations through walls, ceilings, and other fire rated elements
 - 3. Division 26 Section "Hangers and Supports for Electrical Systems" for supports and anchors.
 - 4. Division 26 Section "Identification for Electrical Systems" for identification products.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquid-tight flexible metal conduit.
- E. LFNC: Liquid-tight flexible nonmetallic conduit.
- F. RMC: Rigid metal conduit.
- G. RNC: Rigid nonmetallic conduit.
- H. Cabinets: An enclosure designed either for surface or flush mounting and having a frame or trim in which a door or doors may be mounted.
- I. Device Box: An outlet box designed to house a receptacle device or a wiring box designed to house a switch.
- J. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.
- K. Hinged-Cover Enclosure: An enclosure designed for surface mounting and having swinging doors or covers secured directly to and hinged with the walls of the box.
- L. Outlet Box: A wiring enclosure designed to provide access to wiring systems or for the mounting of indicating devices or of switches for controlling electrical switches.

1.4 SUBMITTALS

- A. Product Data: For conduit and tubing, surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
1. Notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Metal Conduit and Tubing:
 - a. Alflex Inc.
 - b. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - c. Electri-Flex Co.
 - d. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - e. O-Z Gedney; Unit of General Signal.
 - f. Wheatland Tube Co.
 2. Nonmetallic Conduit
 - a. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - b. Cantex Inc.
 - c. Electri-Flex Co.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. RACO; Division of Hubbell, Inc.
 - f. Thomas & Betts Corporation.
 3. Conduit Bodies:
 - a. O-Z Gedney; Unit of General Signal.
 - b. Regal.
 - c. Appleton.
 4. Conduit Seals:
 - a. Chase-Foam CTC PR-855.
 5. Metal Wireways:
 - a. Hoffman.
 - b. Square D.
 6. Boxes, Enclosures, And Cabinets:
 - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - b. Emerson/General Signal; Appleton Electric Company.
 - c. Erickson Electrical Equipment Co.
 - d. Hoffman.
 - e. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - f. O-Z/Gedney; Unit of General Signal.
 - g. RACO; Division of Hubbell, Inc.
 - h. Thomas & Betts Corporation.
 - i. Walker Systems, Inc.; Wiremold Company (The).

2.2 METAL CONDUIT AND TUBING

- A. RMC: Zinc-coated, galvanized steel, GRC. ANSI C80.1 and UL 6.

- B. Aluminum Rigid Conduit: Not allowed unless otherwise noted.
 - C. IMC: ANSI C80.6 and UL 1242.
 - D. Plastic-Coated RMC, IMC and Fittings: NEMA RN 1.
 - E. EMT: ANSI C80.3 and UL 797.
 - F. FMC: Zinc-coated steel.
 - G. LFMC: Flexible steel conduit with PVC jacket. UL 360.
 - H. Fittings for Conduit (Including all Types and Flexible and Liquid-tight, EMT, and Cable): NEMA FB 1; compatible with conduit and tubing materials, listed for type and size with which used, and for application and environment in which installed.
 - 1. EMT: Moisture-resistant, interlocking steel compression type with insulated throats.
 - 2. Flexible Conduit: Liquid-tight with insulated throats.
 - 3. RMC and IMC: Threaded rigid steel type, unless otherwise indicated.
 - 4. PVC-Coated RMC: Use only fittings approved for use with that material.
 - 5. Hazardous (Classified) Locations: Comply with UL 886.
- 2.3 NONMETALLIC CONDUIT
- A. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
 - B. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
 - C. LFNC: UL 1660.
- 2.4 CONDUIT BODIES
- A. General: Types, shapes and sizes, as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws for outdoor installations.
 - B. Metallic Conduit and Tubing: Use malleable iron conduit bodies. Use bodies with threaded hubs for threaded raceways and in hazardous locations.
- 2.5 METAL WIREWAYS
- A. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 (interior or 3R (exterior)).
 - B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
 - D. Wireway Covers: Hinged type (interior) and flanged-and-gasketed type (exterior).
 - E. Finish: Manufacturer's standard enamel finish.
- 2.6 BOXES, ENCLOSURES, AND CABINETS
- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1, UL 514. Galvanized steel with stamp knockouts, threaded screw holes, covers and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs. Types, shape, sizes, and depth as indicated or required for each application. Use cadmium, zinc plated, or corrosion resistant screws and hardware.
 - B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Copper-free aluminum, unless otherwise noted, with integral threaded raceway entrances, and features and accessories suitable for each location including mounting ears and threaded screw holes for devices and closure plugs. Types, shape, sizes, and depth as indicated or required for each application. Use stainless steel screws and hardware.

- C. Cast-Metal Floor Boxes: Cast metal, fully adjustable, rectangular. Copper-free aluminum, unless otherwise noted, with integral threaded raceway entrances, and features and accessories suitable for each location including mounting ears and threaded screw holes for devices, closure plugs, and voltage partitions when required. Use standard depth boxes to permit side conduit entrance without interfering with reinforcing, but do not use boxes with more than 6-inch depth. Types, shape, sizes, and depth as indicated or required for each application. Use stainless steel screws and hardware.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, UL 50. Galvanized steel with welded seams and screwed or bolted-on covers of same material. Construct with internal structural steel bracing, where rigid assembly is necessary. Types, shape, sizes, and depth as indicated or required for each application. Use stainless steel screws and hardware.
- E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, UL 50, cast aluminum with gasketed cover. Copper-free aluminum, unless otherwise noted, with integral threaded raceway entrances, and features and accessories suitable for each location including mounting ears and threaded screw holes for devices and closure plugs. Types, shape, sizes, and depth as indicated or required for each application. Use stainless steel screws and hardware.
- F. Hinged-Cover Enclosures: NEMA 250, Type 1, NEMA ICS 6, and UL 50, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Galvanized steel, 16-gauge minimum with continuous welded seams, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- G. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.
- H. Fittings for Boxes, Cabinets, and Enclosures: UL 514. Malleable iron or zinc plated steel for conduit hubs, bushing and box connectors.

2.7 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard gray baked enamel, unless otherwise indicated, applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 – EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors:
 - 1. Exposed: RMC.
 - 2. Concealed: RMC.
 - 3. Underground: RMC or Schedule 40 or Schedule 80 PVC conduit. At foundation penetrations use a minimum of 60 inches of PVC-coated RMC or painted with two coats of asphaltic paint conforming to NEMA RN 1.
 - 4. Connection to Vibrating or Freestanding Equipment (Including Flow and Tamper Switches, Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): PVC coated LFMC with liquid-tight connectors. Length shall be three feet maximum.
- B. Indoors:

1. Exposed: EMT. RMC below 72 inches above finished floor.
 2. Concealed: EMT.
 3. Connection to Vibrating or Freestanding Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations and to connect Flow and Tamper Switches. Length shall be 36 inches maximum. Install separate ground conductor across flexible connections.
 4. Damp Locations: EMT or RMC.
 5. Wet Locations: RMC.
 6. Embedded in Concrete Slab, Below Grade Level: RNC, except in classified hazardous areas.
 7. Embedded in Concrete Slab, Above Grade Level: RNC, EMT, or RMC.
- C. Minimum Raceway Size: Conduit sizes shall be as shown on the drawings. If the conduit size is not given on the drawings, the conduit shall be sized in accordance with NEC Appendix C based on the number of conductors enclosed plus a parity sized equipment ground conductor and be subject to the following minimum sizes:
1. Rigid Tubing and Conduit: Home runs and branch circuits shall be 3/4-inch minimum and runs terminating in a wiring device may be 1/2-inch minimum.
 2. Flexible and Liquid-tight Flexible Conduit: All homeruns shall be 1/2-inch minimum, except luminaire and control wiring may be 3/8-inch.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz or where indicated on drawings. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits embedded in or in contact with concrete.

3.2 BOXES, ENCLOSURES, AND CABINET APPLICATIONS

- A. Metal Outlet, Device, and Small Wiring Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
1. Interior Dry Locations: Sheet steel, NEMA 250, Type 1.
 2. Locations Exposed to Weather or Dampness: Cast metal, NEMA Type 3R.
 3. Wet Locations: Stainless steel, NEMA 250, Type 4.
- B. Outlet, device, and wiring boxes shall be provided for all luminaires, wiring devices, and equipment connections. Boxes shall be of size and type to properly accommodate the size and number of raceways and conductors entering the box. Device boxes shall not be less than 1-1/2 inches deep.
- C. Pull and Junction Boxes: Install pull and junction boxes of other materials and NEMA types suitable for each location except as otherwise indicated.
- D. Hinged-Cover Metal Enclosures (Indoor): NEMA 1 enclosure, unless otherwise indicated.
- E. Cabinets: NEMA 1 enclosure, unless otherwise indicated.

3.3 INSTALLATION

- A. Install electrical raceways and boxes in accordance with manufacturer's written installation instructions and applicable requirements of NEC.
- B. Conceal conduit, EMT, and boxes within finished walls, ceilings, and floors, unless otherwise indicated.
- C. Support raceways and boxes as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

- D. Refer to Division 26 Section "Through-Penetration Firestopping for Electrical Systems." for firestopping materials, pipe sleeves and installations at penetrations through walls, ceilings, and other fire rated elements.
- E. Install temporary closures to prevent foreign matter from entering raceways and boxes. Thoroughly clean foreign material from boxes before conductors are installed.
- F. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping keep to structure. Otherwise, install raceways level and square and at proper elevations.
- G. Complete raceway installation before starting conductor installation.
- H. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- I. Make bends and offsets so inside diameter is not effectively reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
 - 1. Conduit larger than 1 1/4 inch: Bends shall be factory-made elbows, unless otherwise approved.
 - 2. Conduit 1 1/4 inch and smaller: Bends shall be made in an approved bending machine or factory made.
 - 3. Hickey bends will not be permitted for conduits larger than 3/4 inch.
 - 4. Bends and offsets in each run of conduit shall be kept to a minimum. Where excessive bends are required, the size of the conduit shall be increased in accordance with requirements of the NEC.
 - 5. There shall be no more than a maximum of four 90 degree bends per run of conduit.
- J. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to PVC-coated RMC before rising above the floor.
- K. Install concealed and exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible with a minimum of bends and the shortest practical distance, unless otherwise indicated.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- L. Do not attach raceway to underside of metal roof decking. Raceways shall be installed a minimum of 3 inches below to avoid roofing nail penetrations.
- M. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors when subject to vibration and dampness.
 - 2. When joints cannot be made tight or subject to vibration use bonding jumpers to provide electrical continuity of the raceway system.
 - 3. Joints in EMT shall be secured for grounding purposes by means of concrete-tight connections of the interlocking compression ring, or stainless steel multiple joint locking ring type with insulated throat connectors.

4. Joints in non-metallic conduits shall be made with solvent cement in strict accordance with manufacturer's recommendations.
 5. Install expansion/deflection couplings across all structural expansion joints and at a point at least once in every 200 feet of linear conduit run. A flexible bonding jumper at least three-times the nominal width of the joint shall also be installed across non-grounding type expansion couplings.
- N. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - a. RMC and IMC shall be secured with double locknuts and an insulated metallic bushing.
 - b. EMT shall be secured with one locknut and shall have nylon-insulated throats or threaded nylon bushings for 3/4 inch to 1 inch. 1 1/4 inch and above shall be metal with nylon insulated throats. Use grounding type bushings for feeder circuits at switchboards, panelboards, pull boxes, transformers, motor control centers, VFD's, etc.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- P. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- Q. Install raceway sealing fittings in accordance with manufacturer's instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits enter or leave hazardous locations.
 2. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces and air conditioned spaces.
 3. Where otherwise required by NFPA 70.
- R. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- S. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and in existing walls, movable partition, or within casework. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- T. Wireways: Where indicated on drawings, shall be hinged cover or screw cover type with all necessary parts and fittings, which shall be of one manufacturer. Install an insulated grounding conductor in all wireways. Bond grounding conductor to all wireways.
- U. Exposed raceways and boxes shall be painted to match walls with paint acceptable to Architect.

- V. Conduit passing through concrete walls shall be fire-sealed.
- W. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations as required:
 - 1. Where sleeves through floors are installed, extend above finish floor.
 - 2. Where individual conduits penetrate fire-rated walls and floors, provide pipe sleeve one size larger than conduit; pack void around conduit with fire rated insulation and seal opening around conduit with UL-listed firestopping sealant in accordance with Division 26 Section "Through-Penetration Firestopping for Electrical Systems." Conduits on trapeze type support system shall require fire taping only. See Architectural plans for location and extent of fire rated assemblies.
 - 3. Where conduits are to be installed through structural framing members, the contractor shall provide sleeves. For areas where sleeves have not been provided, the Architect's written approval must be obtained prior to cutting, notching or drilling of structural framing members.
- X. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.
- Y. Use of running threads for rigid conduit shall not be permitted. When threaded couplings cannot be used, provide 3-piece union or solid coupling.
- Z. Conduits shall not cross pipe shafts or ventilation duct openings. Where conduits must penetrate airtight spaces or plenums, seal around the conduit with a mastic, acceptable to the Architect.
- AA. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through jack with pitch pocket.
- BB. Provide separate raceway systems for each of the following:
 - 1. Lighting
 - 2. Power Distribution
 - 3. Low voltage systems, including telephone and communications, security, and fire alarm.
- CC. Provide waterproofing of all raceways, fittings, etc., which penetrate the roof to preserve the weatherproofing integrity of the building. Installation of materials shall conform to the following:
 - 1. Install all raceways concealed except at surface cabinets, for motor and equipment connections and in mechanical equipment rooms. Install a minimum of 6 inches from flues, steam pipes or other heated pockets for water-flashing and counter-flashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc., which penetrate roof. Route parallel or perpendicular to building lines with right angle turns and symmetrical bends. Concealed raceways shall be run in a direct line, and where possible, with long sweeping bends and offsets.
 - 2. Provide raceway expansion joints with necessary bonding conductor at building expansion joints and where required to compensate for raceway or building thermal expansion and contraction. Terminate raceways 1 1/4 inch and larger with insulated bushings or rain tight connections with insulated throats.
- DD. Set outlet, device, and wiring boxes flush with finished wall or ceiling, unless noted otherwise. Set floor boxes level and flush with finished floor surface.
- EE. Boxes shall be ganged where two or more occur at the same location.
- FF. Sizes of boxes, enclosures or cabinets shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated. For ceiling boxes, where wiring is concealed, use outlet boxes 4-inches square by 1-1/2-inches deep, minimum. For boxes in main feeder conduit runs, use sizes not smaller than 8-inches square by 4-inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box. Quantities

of conductors (including equipment grounding conductors) in pull or junction box shall not exceed the following:

Size of Largest Conductors in Box	Minimum No. of Conductors in Box
No. 4/0 AWG	30
250 MCM	20
500 MCM	15
Over 500 MCM	10

- GG. Install hinged-cover enclosures and cabinets fronts straight and plumb. Support at each corner. Mount at 78 inches from floor to top of enclosure. Cabinets in finished spaces to be flush with walls.
- HH. Remove sharp edges where they may come in contact with wiring or personnel.
- II. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- JJ. Mount outlet boxes for switches with the long axis vertical unless otherwise noted. Mount boxes for receptacles vertically, except above counter receptacles to be mounted horizontally. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates such that they will not span different types of building finishes either vertically or horizontally. Provide far side box supports for electrical boxes installed on metal studs.
- KK. Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even when electrical floor plans may show them on hinge side. Locate outlet boxes for receptacles:
1. Window and Door Locations: Close to window trim in an accessible location. For outlets indicated above doors center outlets above the door opening unless otherwise noted.
 2. Column and Pilaster Locations: Such that centers are clear for future installation of partitions.
 3. Special Finish Material Locations: Mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, shall use rectangular shaped boxes without plaster rings. Saw cut all recesses for outlet boxes in exposed masonry walls
- LL. In block masonry construction, rough-in heights may be adjusted to suit block course; box shall occur at the top or bottom of the masonry unit.
- MM. Use cover plates sized to box front without overlap for surface boxes
- NN. Where extension rings are required to be installed for existing boxes, etc., drill new mounting holes in the rings to align with the mounting holes on the existing boxes when necessary.
- OO. Back to back outlet boxes are not permitted. Separate boxes a minimum of 6 inches in standard walls and 24 inches in acoustical walls.
- PP. Use cable supports inside boxes. Install clamps, grids, or devices to which cables may be secured. Arrange cables such that they may be readily identified. Support cables at least every 30 inches inside boxes.
- QQ. When mounting pull box in an inaccessible ceiling, mount with the cover flush with the finished ceiling.

3.4 GROUNDING

- A. Electrically ground metallic cabinets, boxes, and enclosures. Provide a grounding terminal in the interior of the box, enclosure or cabinet, when wiring to an item, which includes a grounding conductor.
- B. Install an insulated ground conductor in all conduits.

3.5 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching corrosion inhibiting touchup coating recommended by manufacturer.
- B. Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate-finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

3.6 CLEANING

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

-- END OF SECTION 260533 --

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

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

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Comply with ANSI C2.
- D. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 – PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ideal Industries, Inc.
 - 2. LEM Products, Inc.
 - 3. Markal Corporation.
 - 4. Panduit Corporation.
 - 5. W.H. Brady Co.
 - 6. 3M Company.
- B. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but must provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

2.2 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage and service.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.

- C. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.
- D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- E. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Embedded continuous metallic strip or core that is metal-detector detectable. Printed legend indicating type of underground line.
- F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.3 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. or 8 inches in length and 1/8 inch thick for larger sizes. Punched or drilled for mechanical fasteners. Engraved legend shall be a minimum height of 3/8-inch.
 - 1. Normal: Black characters on white background.
 - 2. Ground: White characters on green background.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 20-gauge galvanized-steel backing; with colors, legend, and size required for the application. Provide 1/4-inch grommets in corners for mounting.
- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties, 3/16-inch minimum width, 50 lb minimum tensile strength, suitable for a temperature range from minus 50 degrees F to 350 degrees F, and UV resistant for outdoor installations. Provide ties in specified colors when used for color coding.
- B. Paint: Formulated for the type of surface and intended use.
 - 1. Primer for Galvanized Metal: Zinc-rich, single-component acrylic vehicle formulated for galvanized surfaces.
 - 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
 - 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
 - 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those

- required by codes and standards. Use consistent designations throughout Project. Install numbers, lettering, and colors as approved in submittals and as required by code.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
 - D. Self-Adhesive Identification Products: Clean surfaces before applying.
 - E. Install painted identification according to manufacturer's written instructions and as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime surfaces using type of primer specified for surface.
 - 3. Apply one intermediate and one finish coat of enamel.
 - F. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 - 1. Bands: Pre-tensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
 - 3. Apply the following colors to the systems listed below:
 - a. Telecommunication System: Green and yellow.
 - b. Computer and Data System: Green and blue.
 - c. Grounding System: Green.
 - G. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
 - H. Circuit Identification Labels on Boxes: Install labels externally.
 - 1. Exposed Boxes in Unfinished Areas: Indelible marker (black).
 - 2. Concealed Boxes: Indelible marker (black).
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
 - 4. Fire alarm boxes shall have covers painted red.
 - I. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Limit use of line markers to direct-buried cables.
 - J. Color-Coding of Secondary Phase Conductors: Factory applied color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 4 AWG.
 - 1. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - 2. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length
 - 3. Use the following colors for service, feeder, and branch-circuit phase conductors:

277/480V., 3 PH.120/208V., 3 PH.120/240V., 1 PH.

Phase A - Brown
Phase B - Orange
Phase C - Yellow
Neutral - Gray
Ground - Green

Phase A - Black
Phase B - Red
Phase C - Blue
Neutral - White
Ground - Green

Phase A - Black
Phase B - Red
Neutral - White
Ground - Green

- K. Power-Circuit Identification: Metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and engine generator rooms.
1. Legend: 1/4-inch- steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 2. Fasten tags with nylon cable ties; fasten bands using integral ears.
- L. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
 4. Match identification markings with designations used in panelboard shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- M. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install where required by the NEC, where indicated, or where reasonably required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install where required by the NEC, where indicated, or where reasonable required to ensure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved laminated signs with white legend on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- N. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch-high lettering on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Surge protection device.
 4. Disconnect switches.

5. Enclosed circuit breakers.
6. Push-button stations.
7. Contactors.
8. Remote-controlled switches.
9. Control devices.
10. Transformers.

-- END OF SECTION 260553 --

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Vibration and seismic controls for electrical systems:
 - a. Isolation pads.
 - b. Spring isolators.
 - c. Restrained spring isolators.
 - d. Channel support systems.
 - e. Restraint cables.
 - f. Hanger rod stiffeners.
 - g. Anchorage bushings and washers.
 - 2. Vibration and seismic controls for the following electrical equipment:
 - a. Conduit.
 - b. Panelboards
 - c. Control Panels, and other Electrical Enclosures.
 - d. Luminaires.
 - e. Transformers.
 - f. Disconnect Switches.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factor: 3.0.
 - c. Component Amplification Factor: 1.0.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): Refer to Structural Drawings.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period: Refer to Structural Drawings.

1.4 SUBMITTALS

- A. Product Data: For each type and size of seismic protection component used.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
 - 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 - 3. Field-fabricated supports.
 - 4. Seismic-Restraint Details.
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
- C. Welding certificates.
- D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from OSHPD, pre-approval by ICC-ES, or pre-approval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- D. Comply with NFPA 70.

PART 2 – PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kinetics Noise Control.
 - 2. Mason Industries.
 - 3. Vibration Eliminator Co., Inc.
 - 4. Vibration Mountings & Controls, Inc

- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 3. Hilti Inc.
 - 4. Mason Industries.
 - 5. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

- D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. 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.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 – EXECUTION

3.1 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during

coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 2. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 3. Test to 90 percent of rated proof load of device.
 4. Measure isolator restraint clearance.
 5. Measure isolator deflection.
 6. Verify snubber minimum clearances.
 7. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

-- END OF SECTION 260548--