SECTION 230000 - GENERAL MECHANICAL REQUIREMENTS

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 SCOPE

A. The Scope of the Mechanical work shall be as described and shown within the Division 23 Construction Documents.

B. The Contractor shall include all work necessary to examine the site, building and mechanical services, and to plan, layout, execute, hoist, transport, measure, rough-in, place in position, final connect, start, test, adjust and demonstrate the mechanical work, systems and equipment.

C. It is a requirement of the Contract Documents that the Contractor shall provide completely finished work, tested and ready for operation by the Owner.

D. The Contractor shall provide all labor, supervision, materials, tools, transportation, equipment, permits, insurance and temporary protection necessary to perform the work.

E. Any apparatus, appliance, material or work not shown on the Drawings but mentioned in the Specifications, or vice versa, and any accessories necessary to make the work complete in all respects, and ready for operation, even if not particularly shown or specified, shall be provided without additional expense to the Owner.

F. Details not usually shown or specified, but necessary for proper installation and operation, shall be included, the same as if herein specified.

G. Prior to submitting a bid or proposal for performing the work, if in doubt as to the meaning or intent of the Contract Documents, or if any errors or omissions are discovered in the Documents, the Contractor shall request in writing an interpretation clarifying or correcting the Contract Documents. No additional payment will be made for any misunderstanding of work to be provided, it being understood that tender of bid or proposal carries with it complete agreement to all items and conditions referred to herein, as indicated on the Drawings, and complying with the intent of the Plans and Specifications. Architect/Engineers interpretation of design intent and extent of required work shall be final.

1.3 DEFINITIONS

A. "Approved Equal", or "Equal", means that throughout the Specifications, types of materials and equipment may be specified by a single manufacturer's name and catalog number in order to

establish standards of appearance, quality and performance, and not for the purpose of limiting competition. Unless specifically stated otherwise, the Contractor may assume the phrase "or approved equal" except that the burden is upon the Contractor to prove such equality. If the Contractor elects to substitute any material or equipment, prior to submitting a Bid or Proposal, he must request the Architect's/Engineer's approval, in writing, to substitute such items for the specified items, stating the differences involved with supporting data, and samples if requested, to permit a fair evaluation of the proposed substitute with respect to appearance, quality, service, ability, warranty and cost. Any such approved substitution shall be identified in the Bid Form. Substitutions after Bid Award will not be accepted.

B. "Complete" means to include all items and work necessary for the function and operation of systems consistent with the intent of all Construction Documents and the project as a whole.

C. "Concealed" means hidden from sight as in chases, furred spaces, shafts, above hung ceilings, or embedded in construction.

D. "Contractor" means specifically the Contractor or Subcontractor providing work under this Division of the Specification.

E. "Ductwork" means duct, fittings, hangers and accessories related to such ductwork.

F. "Engineer" means E & S Construction Engineers, Inc., or their designated representative.

G. "Exposed" means not "concealed" as defined above. Work in trenches, crawl spaces, and tunnels shall be considered "exposed" unless otherwise specifically noted.

H. "Furnish" means to supply and deliver to the Project Site.

I. "Install" means to rough-in, place in position, and provide final connection to materials or equipment, complete and ready for use.

J. "Invert Elevation" means the inside bottom of pipe.

K. "Mechanical" means work or systems specified under Specification Division 23.

L. "Piping" means pipe, fittings, valves, hangers, and accessories related to such piping.

M. "Plans" or "Drawings" means drawings prepared by E & S Construction Engineers, Inc., unless noted otherwise.

N. "Provide" means to furnish and install in complete readiness for regular operation, with reference to the particular work.

O. "Specifications" means Division 23 Specifications prepared by E & S Construction Engineers, Inc., unless noted otherwise.

P. "Work" means labor, materials, equipment, supervision, transportation or services.

1.4 CONTRACTOR QUALIFICATIONS

A. The Contractor shall be a financially solvent individual, partnership, or corporate entity, having all required licenses, permits, insurance coverages, and bonding capacity necessary to legally execute the Contract, and perform the work.

B. The Contractor shall be fully qualified, having the required skilled labor, experience, and expertise to properly furnish and install the work as indicated in the Contract Documents.

C. The term "Contractor" shall be referred to throughout the Contract Documents as if singular in number, and masculine in gender, and it shall refer to the Contractor, or his authorized representative.

D. The Contractor shall, if so demanded, present certified written documentation as evidence of his qualifications.

1.5 CODES AND STANDARDS

A. In general, the Specifications and Drawings shall govern, and the Codes and Standards shall be considered as minimum requirements.

B. Where variances from the Specifications and Drawings are necessary in order to comply with the Codes and Standards, perform such work as required.

C. Where requirements of the Codes and Standards conflict with requirements of the Specifications and Drawings, provide all work in compliance with the most stringent requirement.

D. All Mechanical work shall be in strict accordance with all applicable Codes, Standards, and Regulations, specifically including but not limited to:

1. The Construction Code (IBC)/USBC Part 1.
2. The Mechanical Code (IMC).
3. The Plumbing Code (NSPC).
4. The Energy Conservation Code.
5. 2016 NEC (National Electrical Code) / NFPA 72.
6. Underwriters Laboratories Applicable Standards.
7. Requirements of the Owner’s Insurance Underwriter.
8. Requirements of the Americans with Disabilities Act.

E. In addition, all Mechanical work shall comply with Local, State and Federal requirements, and shall meet the minimum requirements as established by OSHA standards, along with Utility Company regulations and governing Industry requirements.

F. All applicable Codes, Standards and Regulations constitute an integral part of the Specifications.

1.6 PERMITS, INSPECTION AND CERTIFICATION

A. The Contractor shall secure and pay for all required permits for the removal and installation of the Mechanical Systems, as required by the authorities having jurisdiction.

B. The Contractor shall secure and pay for all required inspections.

C. Certificates of final inspection and approval required by agencies or authorities having jurisdiction shall cover all mechanical work.

D. All Certificates of final inspection and approval shall be delivered to the Architect prior to final acceptance of the mechanical work.

1.7 APPLICABLE PUBLICATIONS

A. Throughout the Specifications, references are made to Publications, Standards and Specifications of various agencies and organizations. The agencies and organizations are referred to by abbreviation, the following is a tabulation of the abbreviated and full name of the agencies and organizations:

1. AABC - Associated Air Balancing Council.
2. ADC - Air Diffusion Council.
3. AGA -American Gas Association.
4. ANSI - American National Standards Institute, Inc.
5. ARI - Air Conditioning and Refrigeration Institute.
6. ASHRAE - American Society of Heating, Refrigerating, and Air Conditioning Engineers.
7. ASME - American Society of Mechanical Engineers.
8. ASPE - American Society of Plumbing Engineers.
9. ASTM - American Society for Testing and Materials.
10. AWWA - American Water Works Association.
11. CISPI - Cast Iron Soil Pipe Institute.
12. CTI - Cooling Tower Institute.
13. FM - Factory Mutual Engineering Corporation.
14. NAPHCC - National Association of Plumbing-Heating- Cooling Contractors.
15. NEBB - National Environmental Balancing Bureau.
16. NEC - National Electrical Code.
17. NEMA - National Electrical Manufacturers Association.
18. NFPA - National Fire Protection Association.
19. NSF - National Sanitation Foundation.
20. PDI - Plumbing and Drainage Institute.
21. SMACNA - Sheet Metal and Air Conditioning Contractors National Association, Inc.
22. UL - Underwriter's Laboratories, Inc.

B. Where reference is made to "Manufacturer's recommendations", obtain and comply with the installation, operation, and maintenance requirements as furnished by the equipment manufacturer.

1.8 ARCHITECT-ENGINEER-OWNER-CONTRACTOR RELATIONS

A. Acceptance of this Contract by the Contractor is with the specific understanding that the Architect/Engineer assumes a technical responsibility for the design of the mechanical systems proposed for this Project.

B. The Architect/Engineer is not responsible for supervision of the work and is not involved or responsible in any way with physical construction operations.

C. The Architect/Engineer will periodically observe the installation and will report his findings to the Owner.

D. The Contractors are responsible for all physical construction operations, shall provide proper supervision and coordination and provide for the safety of their personnel employed on this Project.

1.9 DRAWINGS, SPECIFICATIONS, AND RELATED DATA

A. One (1) complete set of Drawings and Specifications shall be maintained at the job site and shall be available to the Architect/Engineer upon demand.

B. The intent of the Drawings and Specifications is that the Contractor provide labor and materials, equipment and transportation necessary for the proper execution of the entire work unless specifically noted otherwise. The Contractor shall do the work shown on the Drawings and described in the Specifications, and incidental work necessary to complete the project in a finished and acceptable manner, ready for use, occupancy and operation by the Owner.

C. The Drawings are essentially diagrammatic and indicate the general arrangement of the Mechanical Systems and work required for the project. Although size and location of equipment are drawn to scale, make use of all data in the total Contract Documents and verify such data at the building site.

D. The Drawings indicate required size and points of termination of piping and ducts, and indicates proper routes to conform to structure, avoid obstructions, and preserve clearances. It is not intended that the Drawings indicate all necessary offsets, and the Contractor shall make the installation in a workmanlike manner to conform to the structure, to avoid obstructions, to preserve head room, and to keep openings and passageways clear without additional instruction, and without additional cost to Owner.

E. Dimensions indicated on the Plans shall be used in preference to scaling the Drawings. Where the work is affected by finish dimensions, obtain such dimensions from the Architectural Drawings and verify the information at the Building site.

F. Consult the Architectural Drawings for the exact locations of fixtures, thermostats, outlets, and similar exposed items. Where exposed items are not definitely located on the Drawings, obtain this information from the Architect prior to installation of rough-in or final work.

G. These Specifications include incomplete sentences. Omitted words or phrases shall be supplied by inference. The intentional omission of words or phrases includes, but is not limited to, "any", "all", "a", "the", "an", "as shown", "as specified", "the Contractor shall".

H. All Discrepancies between Code Regulations, the Drawings, Specifications, site conditions, or errors or omissions in the Drawings or Specifications shall be reported to the Architect/Engineer prior to submission of Bid Proposal. The Architect/Engineer will then interpret and/or modify said discrepancies to insure that the contractors bid will be complete in every respect. All work performed by the Contractor after his discovery of such discrepancies, shall be done at the Contractor's own risk and cost.

I. In the event of conflicts in the Contract Documents, the most stringent requirements shall apply. In cases of conflict, the final decision shall be made by the Architect/Engineer.

J. Additional instructions may be issued during the progress of the work by means of Drawings, or otherwise, to make clearer or more explicit the Drawings and Specifications, or as may be necessary to explain or illustrate changes in the work to be done.

K. Each item of equipment shall be installed in strict accordance with the manufacturer's published directions. Obtain these directions and make the installation accordingly. Discrepancy between the manufacturer's directions and the Contract Documents shall be brought to the attention of the Architect/Engineer, in writing, prior to installing the affected work.

L. Coordinate the Mechanical work with all other trades to maintain clearances, and to avoid interference with other work. The Contractor shall assume all responsibility for any corrective work necessary due to lack of coordination.

M. Where grammatical or typographical errors appear, such errors shall not alter the intent of the Plans and/or Specifications.

N. It is not intended that the Plans and Specifications indicate every device, fitting or accessory. The Contractor shall provide such items as necessary to complete the work.

1.10 EXAMINATION OF SITE

A. Prior to submission of Bid or Proposal, examine site of the proposed work and determine all conditions that may affect the work.

B. No extra compensation, consideration or allowance will be granted for failure to visit site, or for any alleged misunderstanding of conditions or work to be done.

1.11 WORKMANSHIP

A. The entire work provided in this Specification shall be constructed and finished in every respect in a First Class workmanlike and substantial manner, in accordance with the best trade practice and to the satisfaction of the Architect/Engineer. Sloppy or amateurish appearing work will not be acceptable and shall be replaced at the Contractor's expense.

B. Examine all other Sections of the Specification and all Drawings for the relationship of the work under this Section, and the work of other trades. Cooperate with all trades and coordinate all work under this Section.

C. As indicated on the Plans, certain work may be exposed to public view. Unless indicated otherwise the exposed work shall be installed parallel and/or perpendicular to visible building elements, with ductwork and pressure piping installed level in the horizontal plane.

D. All exposed work shall be free of any damage or defects as may occur during manufacturing, fabricating, or installing the work.

1.12 JURISDICTIONAL DISPUTES

A. It shall be the responsibility of the Contractor to pay all costs for sub-contracting any work under this Division of the Specifications in order to avoid work stoppages due to labor jurisdictional disputes.

B. Such sub-contracting shall be performed without any additional payment to the Contractor, it being the responsibility of the Contractor to be completely cognizant of trade or union agreements applicable to work performed on the project.

1.13 EQUIPMENT AND MATERIALS

A. All materials and equipment shall be new, the best of their respective kinds, and suitable for the conditions and duties imposed on them.

B. The Contractor shall set-in-place and connect all material and equipment furnished under this Section, and all material and equipment furnished under other Sections, if such work is claimed by trades or unions performing work under Division 23.

C. Verify exact service requirements for each piece of equipment receiving connections. Provide proper Mechanical service for each.

D. Include any and all items required by the local governing codes and/or field conditions for the proper connection and installation of each piece of equipment.

E. To insure proper coordination, furnish complete Wiring Diagrams for all equipment provided under this Division of the Specifications.

1.14 MANUFACTURER'S NAMEPLATES

A. Each major component of equipment shall have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place. Nameplate of a distributing agent will not be acceptable. ASME code ratings, or other data which is die-stamped into surface of equipment shall be stamped in an easily visible location.

1.15 IDENTIFICATION

A. All equipment shall be properly labeled with stenciled lettering or permanent markers.

B. Refer to other Sections within Division 23 Mechanical Specifications for other requirements.

C. Markers, labels and tags shall be located in Areas where readily accessible and visible and shall be permanently affixed.

D. Where identification markers are exposed to the elements they shall be of a material suitable for such applications.

E. Paper or cardboard markers will not be accepted.

1.16 SCAFFOLDING, RIGGING, HOISTING, AND FIELD ASSEMBLY

A. Provide all scaffolding, rigging and hoisting services necessary for the erection, and/or delivery into the premises, of any material, equipment and apparatus furnished. Remove same from the premises when no longer required.

B. Each trade shall consider, in preparing his bid, the difficulty of the installation of the items of material, equipment and apparatus to be provided on the project.

1.17 PROTECTION OF WORK AND PROPERTY

A. The Contractor shall be responsible for the maintenance and protection of all new equipment, materials and tools, supplied by him and stored or installed on the job site, from loss or damage of all causes, until final acceptance by the Owner.

B. The Contractor shall be responsible for the protection of any rough-in, concealed, or finished work of other trades from damage or defacement by his operations and must remedy any such damage at his own expense.

1.18 ACCESSIBILITY

A. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to, unit heaters, valves, dampers, etc. If required for better accessibility, access doors for this purpose shall be provided. Minor deviations from Drawings may be made to allow for better accessibility, but changes of any magnitude which involve extra cost shall not be made without approval from the Architect/Engineer.

B. Minimum clearances in front of or around equipment shall conform to the latest applicable code requirements; and manufacturer's recommendations.

C. The Contractor shall provide the exact locations of concealed items in order that ceiling markers provided under work of other Sections may be affixed to the ceiling's finished material to indicate where access is required above removable hung ceilings.

1.19 CUTTING, PATCHING AND DRILLING

A. The Contractor shall perform his work in a timely and orderly manner so as to avoid any cutting, patching or drilling.

B. It is intended that the Mechanical contractor provide sleeves as required for his work, and that he supplies locations and sizes of openings in other work to the General Contractor, so that such openings can be incorporated in the work of others.

C. Where the requirements for sleeves and openings are not met, the Mechanical Contractor shall make arrangements for and bear the costs of cutting, patching and drilling. All such work shall be made to the complete satisfaction of the Architect/Engineer.

D. Obtain the Architect/Engineer's written approval before any cutting or drilling is made through any new or existing structural element or fire rated floors or walls.

1.20 COVERING OF WORK

A. No duct, pipe, fittings, or other work of any kind shall be covered up or hidden from view before it has been examined, tested, or approved by the Architect/Engineer and/or other authority having jurisdiction over same. Any imperfect work or materials which may be discovered shall be removed and corrected immediately and other work and materials shall be provided which shall be satisfactory to the Architect/Engineer.

1.21 SHOP DRAWINGS AND SUBMITTAL DATA

A. Prepare and submit Shop Drawings and Submittal Data to the Architect/Engineer for his review and approval in accordance with the General Provisions of the Contract.

B. Unless otherwise required, twelve (12) copies of Shop Drawings and Submittal Data shall be submitted.

C. All Submittal Data submitted for review and approval shall be thoroughly edited to clearly indicate items being submitted. Items included on literature being submitted which does not apply to the project shall be crossed out. Submittals not complying with this requirement will be returned for correction, and any consequences as a result of this action will be the responsibility of the Contractor.

D. All data submitted for review shall include a cover page which shall have the following:

1. Project Identification.
2. Contractor Identification.

3. Vendor Identification.
4. Manufacturer Identification.
5. Specification and/or Drawing reference.
6. Clear space for Architects and Engineers review stamps.

E. Shop Drawings shall be prepared to a scale of 1/4" = 1'-0" and shall show dimensioned locations of all equipment, systems and devices. Maximum size of Shop Drawings shall be 30" x 42". Shop Drawings shall show the coordination with other trades work. Shop Drawings shall be submitted for the following:

1. All sheet metal work. At the Contractor's option, Floor Plans showing ductwork layout may be drawn to a scale of 1/16" = 1'-0".

F. Shop Drawings shall include large scale Sections, Elevations, and Details as necessary to clearly indicate the proposed work.

G. Submittal data shall, as a minimum, indicate the following, as applicable:

1. Project Identification.
2. Manufacturer Identification.
3. Name or Model number.
4. Dimensions.
5. Operating weight.
6. Electrical requirements.
7. Performance characteristics.
8. Materials used in manufacture.
9. Color or finish.
10. Approval agencies.
11. All variations from Contract Documents.

H. Submittal data shall be prepared and submitted for the following.

1. Access Doors.
2. Insulation types and installation methods.
3. Heating, Ventilating and Air Conditioning equipment.
4. Sheet metal ductwork fabrication details including duct sizes, gauges, reinforcing, seams and joints, hangers and supports, fittings, branch connections, access doors, acoustical lining, fire dampers, volume dampers, sealing compounds, flexible connections and flexible run-outs, and duct accessories.
5. Registers, grilles and diffusers.
6. Automatic Temperature Control System and components.
7. Testing, adjusting and balancing procedures.

I. Contractor shall bear full responsibility for all submittals, allowing an adequate amount of time for transmitting and review between all parties involved. Submittals may be in the Engineer's possession for Ten (10) working days during the review process. Any work performed prior to the receipt of approved submittals shall be at the risk of the Contractor.

J. Refer to other Sections within Division 23 of the Specifications for other specific requirements regarding Shop Drawings and Submittal Data.

1.22 RECORD DRAWINGS

A. Prepare, maintain and submit Record Drawings to the Architect/Engineer in accordance with the General Provisions and Requirements of the project. Size of Record Drawings shall be 30" x 42".

B. The Record Drawings described above shall be a condition prior to final payment of any sum due. They shall be kept up to date on a regular basis, and shall be available in the field for inspection.

C. General Recording Procedure: Maintain white-print set (blue-line or black line) of Mechanical Contract Drawings in clean, undamaged condition, for mark-up of actual installations which vary from work as shown. Neatly and legibly mark-up the Drawings with a red pencil, showing installed conditions accurately.

1. Work concealed behind or within other work, in non-accessible arrangement.
2. New ductwork layouts, including locations of Air Handling Units, fans, coils, dampers, filters, grilles and similar devices.
3. Concealed control system devices and sensors.
4. Scope of each Change Order, noting C.O. Number.

D. Record Drawings shall be indicated as "As-Built" and shall be dated.

1.23 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. Cooperate with the Owner during final stages of the construction to familiarize him with the details of the installed systems.

B. All instruction periods shall be at the Owner's convenience. Arrange for qualified individuals to provide the instructions, and confirm the instruction periods in writing, giving at least one (1) week notice to the Owner.

C. Upon completion of all work and all tests, each trade shall provide the necessary skilled labor to operate and demonstrate all systems and equipment. Instruction period shall consist of Sixteen (16) Hours time, and may or may not be consecutive hours based on the Owner's preference.

D. During the operating instructions, the Contractor shall demonstrate use of the Maintenance Manual, as well as perform operations, adjustments, and demonstrate maintenance procedures for all equipment.

E. Prior to final acceptance of the systems by the Owner, the Contractor shall prepare a detailed operating and maintenance manual for all equipment and systems. As a minimum, the manual shall contain the following items:

1. Description of Systems.
2. Listing of Manufacturers.
3. Manufacturer's Data - to include:

    a. Copy of approved Submittal.
    b. Descriptive literature, drawings, illustrations, certified performance charts, technical data, etc.
    c. Operation Procedures - Manual and automatic start-up and shut-down procedures, reset and adjustment procedures.
    d. Maintenance Schedule and Procedures - Cleaning, checking and normal replacement items.
    e. Lubrication Procedures - including list of acceptable lubricants and lubrication schedules.
    f. Diagrammatic layouts of the Control Wiring Systems.
    g. Troubleshooting Charts.
    h. Recommended spare parts list. Names, addresses and telephone numbers of recommended repair and service companies.
    i. Manufacturer's Warranty Certificate.
    j. All literature shall be edited to show only those items which apply to this project.

F. Submit a preliminary draft of the manual for approval before the final copy of the manual is prepared. Unless otherwise directed, provide a complete Owner’s Manual in electronic (PDF format) to include all items listed above as well as any additional information necessary for the day to day operation as well as manufacturer’s recommended schedule for maintenance of all installed systems provided under this contract.

1.24 FINAL INSPECTION

A. Contractor shall arrange and schedule final inspection of work and shall notify the Architect, in writing, that the contractor has thoroughly checked his work, and that the work is 100% complete and it is ready for final inspection.

B. During the entire period scheduled for these inspections, the Contractor shall have sufficient and competent personnel present so that operation and adjustments can be made to all systems without delay.

1.25 ACCEPTANCE

A. The operation of the equipment and the mechanical, electrical, and control installation does not constitute an acceptance of the work. Final acceptance will be made after the Contractor completes all work required by the Contract Documents, including any items noted during the final inspection, removes all scrap, debris, construction tools and equipment and furnishes all required Certificates.

1.26 GUARANTEE

A. The Contractor shall guarantee that all work provided shall be free of any defects in workmanship, equipment, and materials for a period of one (1) year. In addition, all Air Handling Units shall have an extended Four (4) Year refrigerant compressor warranty for each compressor.

B. Guarantee period shall begin from opening date of the Mall.

C. Operation of equipment for testing, demonstration, or similar purposes will not be considered as the start of the warranty period.

D. Any defects occurring during the guarantee period shall be promptly repaired or replaced without any additional payment to the Contractor.

E. Examine other Sections of the Specifications for any other guarantee requirements.

PART 2 - PRODUCTS

2.1 QUALITY OF PRODUCTS

A. Equipment or materials not specifically described herein shall be suitable for the purpose for which it is intended, subject to the Architect/Engineer's approval of such equipment or materials.

B. Substitute or approved equal equipment or materials shall have a record of successful operation in area where it is to be installed for a period of at least Two (2) Years prior to being submitted. Proof of successful operation shall be furnished when requested by the Architect/Engineer. No substitutions shall be allowed unless approved prior to bid, and any such approved substitutions shall be identified in the Bid Form.

C. When multiple units of the same class of equipment are required, provide units which are the product of a single manufacturer, however, the component parts of an item or system need not be products of the same manufacturer.

D. All materials and equipment used for the permanent installation shall be new products.

2.2 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS

A. Materials and adhesives used throughout the Mechanical Systems for insulation, and jackets or coverings of any kind, or for piping or conduit systems components, shall have a flame spread rating not over 25 without evidence of continued combustion and with a smoke developed rating not higher than 50. Materials need not meet these requirements where they are entirely located outside of a building and do not penetrate a wall or roof, and do not create an exposure hazard.

B. "Flame Spread Rating" and "Smoke Developed Rating" shall be as determined by the "Method of Test of Surface Burning Characteristics of Building Materials", NFPA No. 225, ASTM E84, Underwriter's Laboratories, Inc. 723; Standard. Such materials are listed in the Underwriter's Laboratories, Inc., "Building Materials List" under the heading "Hazard Classification (Fire)".

2.3 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Provide access doors in finished construction where items requiring access for maintenance, operation, or reading of instruments are concealed. Group together all such items to reduce the quantity of access doors.

B. Minimum size of access door is twelve inches by twelve inches. Provide larger sizes as necessary.

C. Provide a dimensioned shop drawing showing exact locations and sizes of all access doors to be installed in plaster or gypsum board ceilings, finished walls, partitions, floors, etc. Indicate purpose or service for each access door.

D. Access doors shall be Karp or equal, of the following styles:

1. Type KRP-150FR, for use in fire-rated construction, 16 gage steel frame, 20 gage steel door, continuous hinge, 2 inch thick insulation, flush key lock. All access door locks shall be keyed alike or master key operated.
2. Type DSC-214M, for use in masonry non-rated construction, 16 gage steel frame, 14 gage steel door, continuous hinge, screwdriver operated flush lock, with masonry straps.
3. Type KDW, for use in gypsum board dry wall construction, 16 gage steel frame with dry wall bead, 14 gage steel door, continuous hinge, screwdriver operated flush lock.
4. Type DSC-214PC, for use in plastered surfaces, 16 gauge steel frame with expansion casing bead, 14 gauge steel door, continuous hinge, screwdriver operated flush lock. If required by the Architect provide type DSC-210PL, with 13 gauge steel frame, 16 gage recessed door with metal lath welded to door, continuous hinge, and screwdriver operated flush lock.
5. Type Sesame Slim Trim, for use in concealed spline acoustical tile ceilings, 16 gauge steel frame, 20 gauge steel recessed door, continuous hinge, flush mounted thumb latch, polyurethane gasket.
6. Type KAFA, for use in floor construction, extruded aluminum frame with anchor lugs, 1/4 inch thick panel with abrasive, embossed, or recessed finish as required, secured with flush head screws.

2.4 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting" and is by the General Contractor.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

2.5 FLASHING

A. All flashing, counter-flashing and similar waterproofing of roof curbs and wall penetrations shall be by others.

2.6 LUBRICATION

A. All rotating equipment shall be lubricated and manually turned over while stored at the project or off-site, in accordance with the manufacturer's recommendations.

B. All rotating equipment shall be lubricated prior to initial operation, in accordance with the manufacturer's recommendations.

C. Provide and turn over to the Owner each type of lubricant and applicator as required for all equipment. Quantity of lubricants shall be sufficient to maintain all lubrication schedules during the guarantee period.

D. Where equipment is used for testing or temporary service, provide lubrication services as properly required.

2.7 TOOLS

A. Provide all special purpose tools, gauges, meters and similar equipment required for operation and maintenance, and deliver same to the Owner prior to completion of the Contract.

2.8 MOTORS, STARTERS AND DISCONNECT SWITCHES

A. In general, equipment shall include motors, with both starters and disconnect switches being provided under Division 26 of the Specifications. Refer to the individual Equipment Specifications for exceptions to the General Requirements.

B. Motors less than ½ horsepower shall be rated at 120 Volts, single phase, 60 hertz.

C. Motors ½ horsepower and greater shall be rated at 460 Volts, three phase, 60 hertz.

D. Motors, starters and accessories shall comply with ANSI, NEC, and NEMA standards, as well as Division 26 requirements.

E. Unless otherwise required by duty, location or service, motors shall be drip proof, squirrel cage induction, NEMA Design B with Class B insulation, ball bearings, 1750 RPM, synchronous speed, 1.15 service factor. All motors located within the air stream of fan compartments shall be totally enclosed fan cooled with a 1.0 service factor. All motors located outdoors shall be weatherproof. Single phase motors shall be permanent split capacitor type, NEMA Design N with Class B insulation, ball bearings, 1750 RPM.

F. Motor acceleration time, zero to synchronous speed, shall not exceed 15 seconds. All motors shall be suitable for continuous operation in a 40 degree Centigrade ambient.

2.9 DRIVES AND SHEAVES

A. Each motor driven item of machinery not directly connected to its driving motor shall be equipped with fixed or adjustable V-belt drive assembly as specified.

B. Adjustable pitch sheaves shall be selected so that the required machinery RPM will be obtained with the adjustable sheave set at approximately the mid-position.

C. Drive belts shall properly fit in the sheave grooves. Where multiple belt drive assemblies are required, belts shall be provided in matched sets.

D. Provide removable coupling guards and belt drive guards in conformance to OSHA requirements for each exposed coupling and belt drive assembly.

E. Contractor shall provide Two (2) sheave change, as may be required, for each drive assembly for each Air Handling Unit, Exhaust Fan and Smoke Exhaust Fan. Sheave change shall include matched belt sets. Final selection of sheaves shall be made during or as a result of final system testing, balancing, and adjusting procedures.

2.10 SYSTEM AND EQUIPMENT IDENTIFICATION

A. All systems and equipment shall be properly identified after finish painting of all exposed work.

B. Wording, abbreviations, and numbering shall be consistent with that used to identify the systems and equipment as shown on the schedules or plans.

C. All equipment shall be identified by stenciled lettering at least 2 inches high painted on the equipment. Color shall contrast with background color. For equipment too small to receive such stenciling, provide engraved, laminated phenolic 3-ply nameplates with lettering at least 1/4 inch high. Attach nameplates to equipment with permanent adhesive, screws, or brass valve tag chain. At the Contractor’s option, engraved nameplates with lettering at least 1 inch high may be used for larger equipment in lieu of painted stencils.

2.11 DRIP PANS

A. Where water and drain piping is installed within two feet of electrical controllers, switchboards, panelboards, and similar equipment, provide drip pans constructed of 20 gage galvanized steel with 1 ½ inch high edge rim, properly supported and provided with a 1 ½ inch drain pipe to discharge to the nearest floor drain or service sink.

B. Provide single or multiple drip pans as required by the piping installation.

C. Provide drip pans under roof mounted Smoke Exhaust Fans not connected to ductwork. Refer to Detail on Drawings for requirements.

2.12 PIPING AND DUCTWORK IN ELECTRICAL ROOMS

A. Piping or ductwork shall not be installed in Electrical Rooms, Switchgear Rooms, transformer vaults, telephone or electrical closets, and similar Electrical Rooms, except that HVAC ductwork included as part of the Mechanical service to the electrical room shall be installed.

PART 3 - EXECUTION

3.1 ORGANIZATION OF WORK

A. The work throughout, particularly where exposed to public view, shall be executed in the best and most thorough manner to the satisfaction of the Owner, Architect and Engineer, who will jointly interpret the meaning of the Drawings and Specifications, and shall have the power to reject any work and materials which, in their judgment, are not in full accordance therewith.

B. The work called for under this Contract shall be carried on simultaneously with the work of other trades in a manner such as not to delay the overall progress of the work. The Contractor shall be prepared to furnish promptly to other trades involved at the project all information and measurements relating to the work which they may require. He shall cooperate with them in order to secure the harmony necessary in the interest of the project as a whole.

C. The Contractor shall install his work as required to meet all Construction Schedules.

D. The Contractor shall, at all times, keep a competent superintendent in charge of the work. Such superintendent shall be replaced if unsatisfactory to the Owner, Architect or Engineer.

E. Every facility shall be provided to permit inspection of the work by the Owner or Architect/Engineer during the course of construction.

F. Where items of equipment and/or materials are indicated on the Drawings or in the Specifications as being furnished by other trades for installation by the Contractor, the Contractor will be held responsible for the unloading of such equipment and/or materials from the delivery trucks, and for providing safe storage for same as required pending installation.

G. Where the work of the Contractor is to be installed in close proximity to work of other trades, or where it is evident that the work of the Contractor is to interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the Architect, or required elsewhere in the Specifications, the Contractor shall prepare composite working Drawings and Sections at a suitable scale not less than 1/4" to 1'-0", clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, he shall make necessary changes in his work to correct the condition without extra charge.

3.2 COOPERATION WITH OTHER TRADES

A. It shall be the responsibility of each trade to closely schedule their work, so that the work will be installed at the proper time and without delaying the completion of the entire project. They shall give full cooperation to other trades and shall furnish in writing, with copies to Architect any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. If any trade installs his work before coordinating with other trades or so as to cause interference with work of other trades or cause unacceptable headroom clearance problems, he shall make necessary changes in his work to correct the condition without extra charge.

3.3 SUPERVISION AND QUALITY OF WORK

A. The contractor shall include the services of an experienced superintendent or superintendents for each portion of the work, who shall be constantly in charge of the work, together with qualified journeymen, helpers, and laborers, all as required to unload, install, connect, adjust, start, operate and test the work involved, including equipment and materials furnished by the Owner or others and installed by the Contractor.

B. Unless noted otherwise, equipment and materials acceptable for installation in this project shall be new, and shall be those items mentioned specifically by name, or approved equal, in the Contract Documents.

C. Rejected work and Materials: All work and materials which do not conform to the requirements of the Contract Documents, are not equal to submittals or samples approved by the Architect/Engineer, or are in any way unsatisfactory or unsuited to the purpose for which they are intended, shall be rejected. Rejected work and materials shall be removed within ten (10) days after written notice is given by the Architect, and the work shall be re-executed by the Contractor. The fact that the Architect may have previously overlooked such defective work or materials shall not constitute an acceptance of any part of it. Should the Contractor fail to remove rejected work or material within ten (10) days after written notice to do so, the Owner may remove same and may store or dispose of the removed materials at his discretion, and at the Contractor's expense.

END OF SECTION 230000

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fastener systems.
4. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
2. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, 2-1/2 inches and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to **1**.

3.5 PAINTING

A. Touchup: Clean field welds and 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 a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are required.

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

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes 1/2 inches to 30 inches.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg f, pipes 4 inches to 24 inches, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes 3/4 inches to 36 inches, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes 1/2 inches to 24 inches if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes 1/2 inches to 4 inches, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes 3/4 inches to 8 inches.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes 1/2 inches to 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes 1/2 inches to 8 inches.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes 1/2 inches to 8 inches.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes 3/8 inches to 8 inches.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes 3/8 inches to 3 inches.
12. U-Bolts (MSS Type 24): For support of heavy pipes 1/2 inches to 30 inches.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes 4 inches to 36 inches, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes 4 inches to 36 inches, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes 2-1/2 inches to 36 inches if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes 1 inch to 30 inches, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes 2-1/2 inches to 24 inches, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes 2 inches to 42 inches if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes 2 inches to 24 inches if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes 2 inches to 30 inches if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers 3/4 inches to 24 inches.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers 3/4 inches to 24 inches if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed.
2. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
3. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
2. Laboratory Test Reports for Credit EQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Aeroflex USA, Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed Corp.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap..

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Aeroflex USA, Inc.; Aeroseal.
    b. Armacell LLC; Armaflex 520 Adhesive.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.

e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 TAPES

A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.

d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

      (1). AGM Industries, Inc.; CHP-1.
      (2). GEMCO; Cupped Head Weld Pin.
      (3). Midwest Fasteners, Inc.; Cupped Head.
      (4). Nelson Stud Welding; CHP.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

(1). GEMCO; Nylon Hangers.
(2). Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
c. Spindle: Nylon, 0.106-inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2.8 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. Color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless-Steel Corner Angles:0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation,

install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 3 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over compress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two locations for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed.
2. Indoor, concealed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Vibration-control devices.
4. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1 1/2-lb/cu. ft. nominal density.

B. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1 1/2-lb/cu. ft. nominal density.

END OF SECTION 230713

SECTION 232300 - REFRIGERANT PIPING

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 refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer’s test date, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Quality procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT

A. Lines 4” and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless or packed-angles valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless or packed-angles valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician’s tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg cadmium-free silver alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Pipping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. 1/2” to 5/8”: Maximum span, 60 inches; minimum rod size, 1/4”.
2. 1”: Maximum span, 72 inches; minimum rod size, 1/4”.
3. 1-1/4” to 2”: Maximum span, 96 inches; minimum rod size, 3/8”,
4. 2-1/2”: Maximum span, 108 inches; minimum rod size, 3/8”.
5. 3”: Maximum span, 10 feet; minimum rod size, 3/8”.
6. 4”: Maximum span, 12 feet; minimum rod size, 1/2”.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. 2”: Maximum span, 10 feet; minimum rod size, 3/8”.
2. 2-1/2”: Maximum span, 11 feet; minimum rod size, 3/8”.
3. 3”: Maximum span, 12 feet; minimum rod size, 3/8”.
4. 4”: Maximum span, 14 feet; minimum rod size, 1/2”.

E. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 “Performance Requirements” Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.

c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", ASCE/SEI 7. And SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. LEED Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
4. Duct-Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-Up."
5. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
6. Laboratory Test Reports for Credit EQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment**,** seismic restraints, and vibration isolation.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers, supports and seismic restraints.

E. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

F. Welding certificates.

G. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Minimum Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Minimum Galvanized Coating Designation: G60.
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface].
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3”, 4” or 6”.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10” wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10", positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10", positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

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

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    c. Return Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    d. Exhaust Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 START UP

A. Air Balance: Refer to General Notes, Note 8, for information.

3.9 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Constant-Volume Air-Handling Units:

    a. Pressure Class: Positive 2-inch wg or 3-inch wg.
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 6 or 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 6 or 12.

B. Return Ducts:

1. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive or negative 1-inch wg or 2-inch wg.
    b. Minimum SMACNA Seal Class: C.
    c. SMACNA Leakage Class for Rectangular: 12 or 24.
    d. SMACNA Leakage Class for Round: 12 or 24.

C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Negative 1-inch wg to 3-inch wg.
    b. Minimum SMACNA Seal Class: B or C.
    c. SMACNA Leakage Class for Rectangular: 12 or 24.

D. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

(1). Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
(2). Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

(1). Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
(2). Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
(3). Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Flexible connectors.
3. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. LEED Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

E. Source quality-control reports.

F. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. McGill AirFlow LLC.
    b. METALAIRE, Inc.
    c. Ruskin Company.

2. Standard leakage rating.

3. Suitable for horizontal or vertical applications

B. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. McGill AirFlow LLC.
    b. METALAIRE, Inc.
    c. Ruskin Company.

2. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

1. Minimum Weight: 16 oz./sq. yd.
2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

2.4 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install flexible connectors to connect ducts to equipment.

H. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

I. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

J. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

K. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

DAIKIN HP (DUCTLESS SPLIT HEAT PUMP UNIT): MODEL NUMBER IDU: FBQ48PVJU; ODU RZQ48TAVJUA. SIZE RANGE: 4 TONS NOMINAL.

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. The variable capacity, heat pump system shall be a Daikin Inverter Driven series (heat/cool model) split system. The system shall consist of a wall mounted evaporator model FBQ48PVJU exclusively matched to outdoor model RZQ48TAVJUA exclusively matched to outdoor model RZQ48TAVJUA direct expansion (DX), air-cooled, Daikin swing, variable speed, inverter driven compressor using R-410A refrigerant. The outdoor unit is a horizontal discharge, variable speed, single fan unit using a single-phase power supply. The system shall have a self-diagnostic function, 3-minute time delay mechanism and have a factory pre-charge of R-410A adequate for 33 feet of total line set length. The system shall have automatic restart capability after a power failure has occurred and a low voltage cut-off feature to prevent stalling during power supply issues.

1.2 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 / CSA C22.2 No. 236 – Heating and Cooling Equipment and bear the Listed Mark.

B. All wiring shall be in accordance with the National Electric Code (NEC).

C. Each combination shall be rated in accordance with Air Conditioning Refrigeration Institute’s (ARI) Standard 210/240 and bear the ARI label.

D. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

E. The outdoor unit will be factory charged for a line set length of 33 feet of refrigerant with R-410A refrigerant.

F. A holding charge of dry nitrogen shall be provided in the evaporator.

G. System Efficiency shall meet or exceed 18.5 SEER, 12.2 EER and 9 HSPF.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendations.

PART 2 - WARRANTY

2.1 LIMITED WARRANTY

A. This warranty is provided to you by Daikin North America LLC ("Daikin"), which warrants all parts of this heating or air conditioning unit, as described below.

1. Commercial Installations: This warranty applies to heating and air conditioning units installed in buildings other than residences and covers defects in materials and workmanship that appear under normal use and maintenance. Warranty coverage begins on the "installation date". The installation date is one of two dates: (1) The installation date is the date that the unit is originally installed. (2) If the date the unit is originally installed cannot be verified, the installation date is three months after the manufacture date. The warranty lasts for a period up to 5 YEARS.

2.2 INSTALLATION REQUIREMENTS

A. Installation must comply with installation manual. It is recommended the system be installed by a contractor/dealer who has been through Daikin training programs.

PART 3 - PERFORMANCE

3.1 The system performance shall be in accordance with AHRI 210/240 test conditions as shown in the performance table below.

ODU	IDU	Cooling Capacity Rated (Min. ~ Max.)	Heating Capacity Rated (Min. ~ Max.)	SEER	EER	HSPF
RZQ48TAVJUA	FBQ48PVJU	48,000	54,000-25,800	14	-	10

The cooling performance is based on 80°f db / 67°f wb for the indoor unit and 95°f db / 75°f wb for the outdoor unit and 25 feet of piping. The heating performance is based on 70°f db / 60°f wb for the indoor unit and 47°f db / 43°f wb for the outdoor unit and 25 feet of piping.

3.2 The operating range in cooling will be 50°F DB ~ 115°F DB, and down to -4°F DB when optional wind baffle used and Jumper is cut on ODU.

3.3 The operating range in heating will be 5°F WB ~ 65°F WB.

3.4 The system shall be capable of maximum refrigerant piping as follows. For the 9k btu and 12k btu a max of 65-5/8 feet, with 49-1/4 feet vertical difference. For the 18k btu and the 24k btu a

max of 98-1/2 feet, with 65-5/8 feet maximum vertical difference, without any oil traps or additional components.

PART 4 - PRODUCTS

4.1 INDOOR UNIT

A. General:

1. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.

a. Unit Cabinet:

(1) The indoor unit shall have a white, “wipe-clean” finish.
(2) The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom.
(3) The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.
(4) The cabinet includes:

a) Indoor unit ON/OFF switch, capable of being used when the remote controller is missing. When switch is used, the default setting is AUTO mode, 76°F temperature setting, and AUTO airflow rate.
b) OPERATION lamp that turns blue in COOL mode, yellow in FAN mode and orange in HEAT mode.
c) TIMER lamp that blinks when activated
d) A Signal Receiver that receives signals from the remote controller at a maximum distance of 23 ft. When the unit receives a signal, you will hear the following: 2 beeps – operation start, 1 beep – Setting changed, 1 long beep – Operation stop.

b. Fan:

(1) The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
(2) The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
(3) An auto-swing louver for adjustable air flow (vertically) is standard via the wireless remote control furnished with each system.
(4) The indoor fan shall offer a choice of three speeds, plus quiet and auto settings.
(5) The indoor fan shall be removable without the need to detach the heat evaporator coil or blower.

c. Filter:

(1) The return air filter provided will be a washable filter. Two titanium apatite air-purifying filters are included for additional air filtration.

d. Coil:

(1) The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
(2) All tube joints shall be brazed with silver alloy or phoscopper.
(3) All coils will be factory pressure tested.
(4) A detachable condensate pan shall be provided under the coil with a drain connection.
(5) The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film, rated for up to 500 hours salt spray.

e. Electrical:

(1) The outdoor unit shall be powered with 208-230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60 hertz power from the outdoor unit.
(2) The allowable voltage range shall be 187 volts to 253 volts.

f. Control:

(1) The unit shall have a backlit, wireless remote infra-red controller capable to operate the system. It shall have Cooling Operation, Heating Operation, Automatic Operation, Dry Operation and Fan Only Operation.
(2) The controller shall consist of an On/Off Power switch, Mode Selector, Fan Setting, Swing Louver, On/Off Timer Setting, Temperature Adjustment, °C or °F Temperature Display, Eco+ Mode, Quiet, Sleep, LED and Powerful Operation.

a) On/Off switch powers the system on or off.
b) Mode selector shall operate the system in auto, cool, heat, fan, or dry operation.
c) Fan setting shall provide three fan speeds, plus quiet and auto settings.
d) Swing louver shall adjust the airflow (horizontal and vertical) blades.
1. Vertical movement controlled via remote, horizontal movement controlled manually.
e) On/Off timer is used for automatically switching the unit on or off at specific times during the day.
f) Temperature adjustment allows for the increase or decrease of the desired temperature.
g) Eco+ operation adjusts the operating condition to energy saving level by limiting the maximum power consumption of the air conditioner unit.

h) Quiet operation reduces indoor unit sound pressure level by reducing the indoor unit fan speed.
i) Sleep operation automatically adjusts the temperature setting 0.9°F (0.5°C) up each hour for two hours in COOL to prevent excessive cooling during sleeping hours.
j) LED button shall change the indication display on the indoor unit.
k) Powerful operation allows quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time period.

(3) The controller shall be able to display two-digit fault codes extracted from the indoor unit to aid in troubleshooting.
(4) Temperature range on the remote control shall be 60°F to 86°F in COOL mode, 60°F to 86°F in HEAT mode, and 60°F to 86°F in AUTO mode. The temperature shall be controlled in 1° increments.
(5) The indoor unit microprocessor has the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote control.
(6) The unit shall also have the capability to connect to a smart-device app via wireless adapter.

g. Sound

(1) Indoor unit sound levels shall not exceed:

Indoor Daikin Model	**Cooling Mode Sound Level (H/M/L/SL) dB(A)**	**Heating Mode Sound Level (H/M/L/SL) dB(A)**
FBQ48PVJU	45 / 37 / 31 / 26	45 / 37 / 30 / 26

*values are measured approximately 3 feet away with JIS standard operating conditions.

4.2 OUTDOOR UNIT

A. General:

1. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls. The outdoor shall be controlled by a microprocessor and dedicated EEV's shall be provided for capacity control during part load of the indoor unit.

a. Unit Cabinet:

(1) The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

(2) The outdoor unit will come furnished with four (4) mounting feet, mounted across the base pan, to allow bolting to a cement pad or optionally supplied mounting bracket.
(3) This assembly will be able to withstand a maximum rated wind pressure of 119psf Lateral, 93psf Uplift. See document TER-16-3088.

b. Fan:

(1) The fan shall be a direct drive, propeller type fan.
(2) The motor shall be inverter driven, permanently lubricated type bearings, inherent.
(3) A fan guard is provided on the outdoor unit to prevent contact with fan operation.
(4) Airflow shall be horizontal discharge.

c. Coil:

(1) The outdoor coil shall be nonferrous construction with corrugated fin tube.
(2) The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic, rated for up to 500 hours salt spray.
(3) Refrigerant flow from the condenser will be controlled via a metering device.
(4) Automatic defrost will remove any frost from the outdoor unit allowing the system to maintain heating capacity.

d. Compressor:

(1) The outdoor compressor shall be a patented, variable speed Daikin swing inverter-driven compressor. The one-piece action reduces noise, extends life, boasts higher efficiency and reduces energy consumption.
(2) The outdoor unit shall have an accumulator and four-way reversing valve.
(3) PVE Refrigerant Oil shall be used to provide improved lubrication & better chemical stability, and no hydrolysis, leading to higher product reliability.
(4) The compressor shall have an internal thermal overload.
(5) The outdoor unit can operate with a maximum vertical height difference of 49-1/4 feet for 9k btu and 12k btu and 65-5/8 feet for 18k btu and 24k btu without any oil traps or additional components.
(6) The outdoor unit can operate with an overall maximum length of 65-5/8 feet for 9k btu and 12k btu and 98-1/2 feet for 18k btu and 24k btu without any oil traps or additional components.

e. Electrical:

(1) The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.

(2) The voltage range limitations shall be a minimum of 187 volts and a maximum of 253 volts.

f. Sound:

(1) Outdoor unit sound levels shall not exceed:

Outdoor Daikin Model	Cooling Mode Sound Level dB(A)	Heating Mode Sound Level dB(A)
RZQ48TAVJUA	49	49

*values are measured approximately 3 feet away with JIS standard operating conditions.

4.3 SYSTEM DIAGNOSTICS

A. General:

1. The system shall be capable of producing 2-digit fault codes:

a. Controls:

(1) I/R Controller
(2) Wi-Fi module
(3) Wired controller

b. D-Checker software: The D-Checker software has the ability to display error codes and values for every sensor on the system through the outdoor unit. The sensor data points shall be graphed or recorded for export to a spreadsheet. The spreadsheet can then be analyzed to troubleshoot operational issues or acknowledge proper operation.

END OF SECTION 238126

SECTION 238233 - CONVECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Electric baseboard radiators.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Details of custom-fabricated enclosures indicating dimensions.
3. Location and size of each field connection.
4. Location and arrangement of piping valves and specialties.
5. Location and arrangement of integral controls.
6. Enclosure joints, corner pieces, access doors, and other accessories.
7. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members, including wall construction, to which convection units will be attached.
2. Method of attaching convection units to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For convection heating units to include in emergency, operation, and maintenance manuals.

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.

PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Design Architectural.
2. Chromalox; a division of Emerson Electric Company.
3. Berko Electric Heating; a division of Marley Engineered Products.
4. Qmark Electric Heating; a division of Marley Engineered Products.

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

C. Heating Elements: Wire heating element enclosed and bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.

D. Rust-Resistant Enclosures: Minimum 0.040-inch thick ASTM A 653/A 653M, G60 galvanized-steel, removable front cover.

1. Full-height back.
2. Full-length damper.
3. End panel.
4. End caps.
5. Inside and outside corners.
6. Joiner pieces to snap together.
7. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
8. Element Brackets: Primed and painted steel to support front panel and element.

E. Unit Controls: Integral line-voltage thermostat or Integral electronic thermostat.

F. Accessories:

1. Filler sections without a heating element matching the adjacent enclosure.
2. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before convection heating unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BASEBOARD RADIATOR INSTALLATION

A. Install units level and plumb.

B. Install baseboard radiators according to Guide 2000 - Residential Hydronic Heating.

C. Install enclosure continuously around corners, using outside and inside corner fittings.

D. Join sections with splice plates and filler pieces to provide continuous enclosure.

E. Install access doors for access to valves.

F. Install enclosure continuously from wall to wall.

G. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

H. Install valves within reach of access door provided in enclosure.

I. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.

J. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Connect steam units and components to piping according to Division 23 Section "Steam and Condensate Heating Piping."

1. Install shutoff valve on inlet; install strainer, steam trap, and shutoff valve on outlet.

D. Install control valves as required by Division 23 Section "Instrumentation and Control for HVAC."

E. Install piping adjacent to convection heating units to allow service and maintenance.

F. Ground electric convection heating units according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper convection heating unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 238233