SECTION 15050
BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 1 - General Requirements, and shall include all Mechanical Sections specified herein.

1.2 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
1. Compliance with all codes and standards applicable to this jurisdiction.
2. Shop Drawings for Equipment
3. Coordination Documents
4. Record Drawings
5. Start-up Service and Building Commissioning
6. Instruction, Maintenance, and O & M Manuals
7. Work associated with Delivery, Storage, and Handling of products
8. Work associated with provision of Temporary Facilities
9. Preparation of Posted Operating Instructions
10. Meeting Project Safety and Indemnity requirements
11. Proper Cleaning and Closing
12. Supplying proper Warranty information
13. Supply specified Guarantee documentation
14. Design and provision of Supports and Anchors
15. Design and provision of Seismic Restraints and Vibration Isolation
16. Pipe Portals
17. Roof Curbs
18. Equipment Rails
19. Access Panels and Doors
20. Identification Markers
21. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete plumbing, heating, ventilating, air conditioning and fire protection systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 1.

D. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:
   1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
   2. Before proceeding with work check and verify all dimensions.
   3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
   4. Make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
   5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
   6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible, including during bidding period.

1.5 DEFINITIONS

A. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.

B. "Accessible": Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.

C. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

D. "Below Grade": Buried in the ground or embedded in concrete slab on ground.

E. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

F. "Connect": Complete hook-up of item with required service.

G. "Exposed": Not installed underground or "concealed."

H. "Furnish": To supply equipment and products as specified.

I. "Indicated," "Shown" or " "Noted": As indicated, shown or noted on Drawings or Specifications.

J. "Install": To erect, mount and connect complete with related accessories.

K. "Motor Controllers": Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.

L. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

M. "Provide": To supply, install and connect as specified for a complete, safe and operationally ready system.

N. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.

O. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

P. "Shall": An exhortation or command to complete the specified task.

Q. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

R. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

S. "Typical" or "Typ": Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

T. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

U. "Wiring": Raceway, fittings, wire, boxes and related items.

V. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 15 Mechanical sections included herein.

B. Division 2: Site Work
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 3: Concrete.
   1. All concrete work for Mechanical Division shall be included in Division 15 under the appropriate Sections and shall include:
      a. Concrete curbs and housekeeping pads for the mechanical equipment.
      b. Thrust blocks, pads, and boxes for mechanical equipment.
      c. Coordination of floor drain and floor sink installations in sloped floors.

D. Division 7: Thermal and Moisture Protection.
   1. Flashing and sheet metal.
   2. Sealants and caulking.
   3. Firestopping.

E. Division 9: Painting:
   1. Division 15 installers shall perform all painting, except where specifically stated otherwise in Division 9.
   2. Painting of all exposed steel, piping, ductwork, insulation, equipment and materials.

3. Paint all exposed gas piping, interior and exterior to the building, yellow.

F. Division 10: Miscellaneous Metals.
   1. Exterior louvers and grilles shall be included in this Section.

G. Division 16: Electrical is related to work of:
   1. Fire protection alarms and relays.
   2. Smoke detector and monitoring.
   3. Power connections to all mechanical equipment.
   4. Life safety provisions.

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 15 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All plumbing and mechanical work shall comply with the Americans with Disabilities Act (ADA).

E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:
   1. Building Codes enforced by the Authority Having Jurisdiction in California:
      a. 2007 California Building Code (CBC) based 2006 International Building Code (IBC) with State Amendments.
      b. 2007 California Mechanical Code (CMC) based 2006 Uniform Mechanical Code (UMC) with State Amendments.
      c. 2007 California Plumbing Code (CPC) based 2006 Uniform Plumbing Code (UPC) with State Amendments.
      d. 2007 California Fire Code (CFC) based 2006 International Fire Code (IFC) with State Amendments.
      e. 2007 California Electric Code (CEC) based 2005 National Electric Code with State Amendments.
      f. 2005 Title 24, Part 6 California Energy Efficiency Standards for Residential and Nonresidential Buildings
   2. Local, city, county and state codes and ordinances.
   3. Local Bureau of Buildings.
   4. Local Health Department.
   5. Local and State Fire Prevention Districts.
   6. California Administrative Codes, Title 24

G. Provide in accordance with appropriate referenced standards of the following:
   1. NFPA - National Fire Protection Association.
   2. AABC - Associated Air Balance Council.
   3. CSA - Canadian Standards Association.
   4. ADC - Air Diffuser Council.
   5. AMCA - Air Moving and Conditioning Association.
   6. ANSI - American National Standards Institute.

7. ARI - Air Conditioning and Refrigeration Institute.
8. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers.
9. ASME - American Society of Mechanical Engineers.
10. ASTM - American Society for Testing Materials.
11. AWS - American Welding Society.
12. AWWA - American Water Works Association.
13. FM - Factory Mutual.
14. MSS - Manufacturer's Standardization Society.
15. NEMA - National Electrical Manufacturer's Association.
16. SMACNA - Sheet Metal and Air Conditioning Contractors National Association.
17. UL - Underwriter's Laboratories.
18. ADA - Americans with Disabilities Act.
19. ETL - Electrical Testing Laboratories.
20. ASSE - American Society of Sanitary Engineers.
21. PDI - Plumbing and Drainage Institute.
22. IAPMO - International Association of Plumbing and Mechanical Officials.
23. CISPI - Cast Iron Soil Pipe Institute.

1.8 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375"), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.

B. Current Models. All work shall be as follows:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 15, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

1.9 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Provide and pay for all permits, licenses, fees and inspections.

D. Prepare a Construction IAQ Management Plan meeting the SMACNA IAQ guidelines. See Section 15880 Air Distribution for a summary of requirements.

E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.

F. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 2 through 16 for rough-in requirements.

G. Coordinate mechanical equipment and materials installation with other building components.

H. Verify all dimensions by field measurements.

I. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

J. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

K. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

L. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.

M. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

N. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.

O. Coordinate the installation of mechanical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

P. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

Q. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

R. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

S. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

T. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.10 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include:
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications.
   2. Minor deviations from the mechanical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.11 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 1 requirements.

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.

C. The Contractor shall submit <u>approved</u> Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 16, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 16.

D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Submit six (6) typed copies of submittals. Refer to Division 1 for additional requirements.

1.13 COORDINATION DOCUMENTS

A. The Contractors shall prepare coordinated Shop Drawings to coordinate the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be Overlay Drawings showing each discipline on a single sheet. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The Drawings shall be prepared as follows:
   1. The Sheet Metal (Mechanical) Contractor shall prepare Drawings to an accurate scale of 1/4" = 1'-0" or larger, on reproducible media sheets (vellum) or AutoCAD disks. Obtain reproducibles or AutoCAD files of the HVAC design from the Architect, or Engineer, at cost plus. Drawings are to be same size as Contract Drawings and shall indicate location, size and elevation above finished floor, of all HVAC equipment, ductwork, and piping. Plans shall also indicate proposed ceiling grid and lighting layout, as shown on electrical plans and reflected ceiling plans.
   2. The Plumbing Contractor shall obtain reproducible plans or AutoCAD disks from the Mechanical Contractor, and indicate all plumbing lines including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
   3. The Fire Protection Contractor shall obtain reproducible plans or AutoCAD disks with the detailed mechanical and plumbing work shown. The Sprinkler Contractor shall indicate location of all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
   4. Plans are to incorporate all addenda items and change orders.
   5. Distribute plans to all trades and provide additional coordination as needed.

C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

D. Provide means of access to all valves, dampers, controllers, operable devices, and other apparatus that may require adjustment or servicing.

E. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Architect of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.

F. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

G. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

1.14 RECORD DRAWINGS

A. Before commencing installation, obtain an extra set of prints from Architect, marked "Record." Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project,

1. Obtain a clean set of reproducibles from the Architect or Engineer, at cost plus, and transfer the revisions to these reproducibles in a neat and orderly fashion.

OR

2. Edit project AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit plots of Record Drawings and six copies CD Roms labeled with all record AutoCAD drawing files.

B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.

C. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Refer also to Special Conditions in Division 1 for full scope of requirements.

1.15 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 1.

B. Contractor shall be responsible for providing proper instruction of the Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 15 to be no less than two hours for each piece of equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must be present, incorporated and referenced in the training sessions.

1.16 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.17 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.18 SAFETY AND INDEMNITY

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

B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.19 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.20 WARRANTIES

A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.

B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.21 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
   1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
   2. ASCE 7-05: "American Society of Civil Engineers."
   3. 2006 International Building Code (IBC)
   4. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
   5. SMACNA: "Seismic Restraint Manual: Guidelines for Mechanical Systems."
   6. NFPA: Pamphlet number 13 and 14 for fire protection systems.
   7. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.
   8. Manufacturer: B-Line, Grinnell, Michigan, Tolco, Kin-Line, Simpson, or Superstrut.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.
   1. Adjustable Steel Clevis Hangers: MSS Type 1.
   2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
   3. U-Bolts: MSS Type 24.
   4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
      a. Plate: Unguided type.
      b. Plate: Guided type.
      c. Plate: Hold-down clamp type.
   5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
   6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
   7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
   8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
   9. Adjustable Roller Hangers: MSS Type 43.
   10. Pipe Roll Stands: MSS Type 44.
   11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider

bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
   1. Steel Turnbuckles: MSS Type 13.
   2. Steel Clevises: MSS Type 14.
   3. Swivel Turnbuckles: MSS Type 15.
   4. Malleable Iron Eye Sockets: MSS Type 16.
   5. Steel Weldless Eye Nuts: MSS Type 17.

F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.
   1. Concrete Inserts: MSS Type 18 or Blue Banger Hanger by Simpson
   2. Steel Brackets: One of the following for indicated loading:
      a. Light Duty: MSS Type 31.
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   3. Horizontal Travelers: MSS Type 58.
   4. Internally Threaded Expansion Shell Anchors: By Simpson or approved equal.
   5. Concrete Screw Anchors: Titen HD by Simpson or approved equal.

G. Anchor Bolts: Heavy duty, drilled-in concrete expansion wedge anchor bolts by Hilti, ITW Red Head, or Simpson.Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
   1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
   2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
   3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert.
   4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.

H. Miscellaneous Materials:
   1. Metal Framing: Provide products complying with NEMA STD ML1.
   2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
   3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
   4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
   5. Pipe Brackets: "HoldRite" copper plated brackets. Insulate brackets attached to metal studs with felt.

2.3 SEISMIC RESTRAINT/VIBRATION ISOLATION REQUIREMENTS

A. Equipment, piping, ductwork and all system appurtenances (including weight of normal operating contents) shall be adequately restrained to resist seismic forces. Restraint devices shall be designed and selected to meet seismic requirements as defined in Chapter 16 of the latest edition of the CBC, with State Amendments, and applicable local codes in accordance with Seismic Zone 4 and the applicable Importance Factors and Soil Factors.

B. All anchorages and/or seismic restraints shall be designed by a registered professional Civil or Structural Engineer licensed in the state of the project. Design shall include:
   1. Number, size and location of anchors for floor or roof-mounted equipment. For curb mounted equipment, provide design of attachment of both the unit to the curb and the curb to the structure.
   2. Number, size and location of vibration isolators, seismic restraint devices and their anchorage for vibration-isolated and suspended equipment.
   3. Number, size and location of braces and anchors for suspended piping and ductwork on shop drawings.
      a. The contractor must select a single seismic restraint system pre-designed to meet the requirements of the current version of the CBC, with State Amendments.
      b. Installations not addressed by the selected system must be designed, detailed and submitted along with the shop drawings.
      c. Maximum seismic loads shall be indicated on drawings at each brace location.
      d. Drawings shall bear the stamp and signature of the registered professional engineer licensed in the state of the project who designed the layout of the braces.
   4. Manufacturers: Mason, M.W. Sausse, or Kinetics.

C. Isolated Equipment:
   1. Spring type isolators shall be freestanding and laterally stable and complete with 1/4" neoprene acoustical friction pads or neoprene cup between the spring and the base plate. All mountings shall have leveling bolts. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections compressed spring height and solid spring height. A steel housing shall be included to resist motion due to earthquake loads. A minimum clearance of ¼" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. The housing shall be out of contact during normal operations. Mountings used out of doors shall be hot dipped galvanized. Manufacturer: Mason Industries #SLR series or approved equal.
   2. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Manufacturer: Mason Industries #SLF series or approved equal.
   3. Spring hangers shall consist of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top and steel springs that are free standing and laterally stable seated in a steel washer reinforced neoprene cup at the bottom. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have a neoprene bushing projecting through the steel box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc from side to side before contacting the rod bushing and short circuiting the spring. Manufacturer: Mason Industries #30N or approved equal.

4. Suspended isolated equipment and vessels shall be protected with cable restraints. Cables shall be installed to prevent excessive seismic motion and so arranged that they do not engage during normal operation, starting or stopping. Seismic sway braces shall consist of galvanized steel aircraft cables. Cables braces shall be designed to resist seismic tension loads with a minimum safety factor of 2. Brace end connections shall be steel assemblies that swivel to the final installation angle. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Manufacturer: Mason Industries #SCB, SRC and UC.

D. All non-isolated piping and ductwork shall be protected in accordance with the SMACNA Guidelines. At the Contractor's option, for ease of installation, cable restraint system may be used. Installations not addressed in the SMACNA Guidelines shall be designed by a registered professional engineer who designed the seismic bracing for the suspended piping and ductwork.

E. Isolator Types: Where equipment isolators are not provided by other sections of the specification or shown on Drawings, provide factory fabricated isolator types sized by the manufacturer for the appropriate loading. Model numbers of Mason Industries products are listed below. Products of other manufacturers will be acceptable provided they comply with all of the requirements of this specification and the Drawings. Manufacturers: Mason Industries, M.W. Sausse or Kinetics.
   1. General Exhaust Fans: Factory roof curb.

F. Submittals:
   1. Confirmation of responsible design party (Shop Drawings received without this information will be rejected without review. Architect will be informed of potential delay of project.)
      a. The seismic manufacturer's representative or engineer responsible for preparing the specified seismic submittal package shall send the following documentation of qualification:
         1) The name and professional engineer's license number of the structural engineer who will be responsible for preparing, designing, and stamping the seismic shop drawing information.
   2. Shop Drawings submittal
      a. Stamped seismic restraint calculations.
      b. The type, size and deflection of each isolator proposed.
      c. Details for all the isolators with snubbers proposed and seismic bracing.
      d. Details for steel frames to be used in conjunction with the isolation and seismic restraint of the items.
      e. Clearly outlined procedures for installing and adjusting the isolators, seismic restraints and snubbers.

2.4 PIPE PORTALS

A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.

B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
   1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
   2. Insulation to be 1-½" thick, 3 lb density rigid fiberglass.
   3. Curb to have a raised 3" (minimum), 45° cant.
   4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).
   5. Curb height to be 8" (minimum) above roof deck.
   6. Cant shall be raised to match roof insulation thickness.
   7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide

sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.

8. Manufacturer: Roof Products Systems or Pate.

2.5 ROOF CURBS

A. Where roof curbs are not provided by other Sections of Specifications, provide prefabricated insulated roof curbs as required for equipment or ductwork as shown on plans.

B. Standard curbs, unless otherwise noted, shall be constructed as follows:
   1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
   2. Insulation to be 1-1/2" thick, 3 pound density rigid fiberglass.
   3. Curb to have a raised 3" (minimum), 45° cant.
   4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).
   5. Curb height to be 8" (minimum) above roof deck.
   6. Cant shall be raised to match roof insulation thickness.

C. Curb to be constructed to meet equipment size and weight requirements. Curbs shall be provided by same manufacturer as manufacturer of equipment requiring support, wherever available. Provide tapered curbs to match roof pitch where required.

D. Manufacturer: Mason Industries, Vent Products, Thy Curb or Roof Products Systems.

2.6 EQUIPMENT/PIPING RAILS

A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.

B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
   1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
   2. Provide internal reinforcing supports welded as required to meet application requirements.
   3. Equipment rails to have raised 3" (minimum), 45° cant.
   4. Equipment rails to have 1 1/2" x 1 1/2" wood nailer (minimum) and counterflashing.
   5. Equipment rail height to be 6" (minimum) above roof deck.
   6. Cant shall be raised to match roof insulation thickness.

C. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required.

D. Manufacturer: Pate, Vent Products, Thy Curb or Roof Products Systems.

2.7 ACCESS PANELS AND ACCESS DOORS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve, for fire and combination fire/smoke dampers, and for volume dampers. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.8 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 15 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:
   1. Snap-On Type: Provide pre-printed, semi-rigid snap-on, color coded pipe markers, complying with ANSI A13.1.
   2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
   3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
   4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

C. Plastic Duct Markers:
   1. Provide 4 1/2" x 6" laminated plastic, ANSI A13.1 color coded duct markers with white core lettering.
   2. Nomenclature: Include the following:
      a. Direction of air flow.
   3. Duct service (supply, return, exhaust, etc.).
      a. Duct origin (from).
      b. Duct destination (to).
      c. Design cfm.
   4. Provide a minimum of every 20 feet on all ducts with a diameter or width greater than 12".

D. Valve Tags:
   1. Brass Valve Tags: Provide 1 1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Fill tag engraving with black enamel.

E. Plastic Equipment Signs:
   1. Provide 4-1/2" x 6" plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.
   2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.

d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

F. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

2.9 ELECTRICAL

A. General:
1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 16.
2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
3. Set and align all motors and drives in equipment specified herein.
4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.
6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

B. Quality Assurance:
1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Motors:
1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.
2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors ½ HP or larger shall be rated for 208 or 460 volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than 1/2 HP shall be rated for 120 volt, single phase operation.
4. Temperature Rating: Motor meets class B rise with class F insulation.
5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
   a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
   b. VFD driven motors. To be provided rated for inverter duty (NEMA Standard MG-1, Part 31) and equipped with a shaft grounding device or as an insulated bearing motor.
   c. Bearings:
      1) Ball or roller bearings with inner and outer shaft seals.
      2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
      4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
      5) Enclosure Type:
         a) Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
         b) Guarded drip-proof motors where exposed to contact by employees or

building occupants.

c) Weather protected Type I for outdoor use, Type II where not housed.

d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.

e. Noise Rating: "Quiet."

f. Efficiency:

1) Motors shall meet the NEMA premium efficiency standard

g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:

1. Motor Starter Characteristics:

a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.

b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).

3. Magnetic Starters:

a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.

b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).

c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 15 Controls sections.

d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.

e. Externally operated manual reset.

f. Under-voltage release or protection for all motors over 20 hp.

4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Low Voltage Control Wiring:

1. General: 14 gauge, Type THHN, color coded, installed in conduit.

2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:

1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.

2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS

A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION

A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor's cost. Coordinate wall and ceiling work with the General Contractor, and his sCBContractors in locating ceiling air outlets, wall registers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS

A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.

B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.

C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

D. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

E. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

G. Support sprinkler piping and gas independently of other piping.

H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

I. Hanger Spacing in accordance with following minimum schedules (other spacings and rod sizes may be used in accordance with the SMACNA Seismic Restraint Manual and UPC using a safety factor of five):

1. Steel Pipe (Water Filled):

Pipe Size	Max. Hanger Spacing	Rod Size
1/2" to 1 1/4"	5 feet	3/8"
1 1/2" to 2"	7 feet	3/8"
2 1/2" to 3"	10 feet	1/2"
4" and larger	12 feet	5/8"

2. Steel Pipe (Gas/Air Filled):

Pipe Size	Max. Hanger Spacing	Rod Size
1/2" to 1 1/4"	6 feet	3/8"
1 1/2" to 8"	10 feet	1/2"
10" and larger	10 feet	5/8"

3. Copper Pipe:

Pipe Size	Max. Hanger Spacing	Rod Size
1/2" to 2"	6 feet	3/8"
2 1/2" to 8"	8 feet	1/2"
10" and larger	10 feet	5/8"

4. Glass Pipe:

Pipe Size	Max. Hanger Spacing	Rod Size
1/2" to 2"	6 feet	3/8"
2 1/2" and larger	8 feet	1/2"

5. Plastic/Fiberglass Pipe:

Pipe Size	Max. Hanger Spacing	Rod Size
1/2" to 2"	4 feet	3/8"
2 1/2" to 8"	4 feet	1/2"
10" and larger	4 feet	5/8"

6. CPVC Pipe:

Pipe Size	Max. Hanger Spacing	Rod Size
1/2" to 1"	3 feet	1/2"
1 1/4" to 8"	4 feet	1/2"
10" and larger	4 feet	5/8"

7. PEX:

Pipe Size	Max. Hanger Spacing	Rod Size
All	32"	1/2"

8. Caulked Bell and Spigot and Glass Pipe: Provide hanger for each section of pipe, located at shoulder of bell. Where an excessive number of fittings are installed between hangers, provide additional reinforcing.

J. Sloping, Air Venting, and Draining:

1. Slope all piping as specified and as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in the direction of flow as follows:

Service	Inclination	Slope
Domestic Water	Down	1" per 100'
Soil and Waste	Down	1/4" per foot
Storm Water	Down	1/4" per foot
Sanitary Vent	Up (towards roof terminal)	1/4" per foot

2. Slope all compressed air branch piping down toward main risers at 1" per 10'.
3. Provide drain valves and hose adapters at all low points in piping.
4. Provide vents at all high points in water piping.

K. Provisions for Movement:
   1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
   2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
   3. Insulated Piping: Comply with the following installation requirements:
      a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
      b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
      c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

L. Installation of Anchors:
   1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
   2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
   3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
   4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

M. Equipment Supports:
   1. Provide all concrete bases, unless otherwise furnished as work of Division 3. Furnish to Division 3 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
   2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

N. Adjusting:
   1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
   2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
   3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 ROOF CURBS, EQUIPMENT RAILS, PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust raise of cant to match.

3.6 VIBRATION CONTROL ISOLATORS

A. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.

B. Comply with manufacturer's instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

C. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

D. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

E. Flexible Pipe Connectors: Install on equipment side of shutoff valves.

F. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.7 ELECTRICAL REQUIREMENTS

A. Mechanical Contractor shall coordinate with Division 16 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, plumbing and fire protection, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.

C. Division 15 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 15 Specifications or scheduled on Division 15 Drawings. The specific division of responsibilities between Division 15 and 16 for furnishing or wiring this equipment is as follows:
   1. Division 15 Mechanical Responsibilities:
      a. MOTORS: Furnish and install all motors necessary for mechanical equipment.
      b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 15 equipment, also furnish and install the power wiring between starter and motor.
      c. VARIABLE FREQUENCY DRIVES: Provide all VFD's associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
      d. DISCONNECTS: Provide the disconnects which are part of factory wired Division 15 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
      e. CONTROLS: Division 15 Contractor (including the temperature controls sCBContractor) is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
         1) Control relays necessary for controlling Division 15 equipment.
         2) Control transformers necessary for providing power to controls for Division 15 equipment.
         3) Line voltage thermostats.
         4) Low or non-load voltage control components.
         5) Remote bulb thermostats.

6) Non-life safety related valve or damper actuators.
7) Float switches.
8) Solenoid valves, EP and PE switches.
9) Refrigeration controls. (Division 16 provides power to refrigeration panels.)

f. FIRE AND LIFE SAFETY EQUIPMENT:
1) Fire Sprinkler System: Division 15 is responsible for providing necessary controls including flow switches and alarm bells.
2) Specialized fire suppression systems: Division 15 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 16 is responsible for bringing power to point of connection with the system.

D. Division 16 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 15 Specifications or scheduled on Division 15 Drawings. The specific division of responsibilities between Division 15 and 16 for furnishing or wiring this equipment is as follows:
1. Division 16 Electrical Responsibilities:
a. MOTORS: Provide the power wiring for the motors.
b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on Division 15 factory assembled equipment, Division 16 is to install magnetic starters furnished by Division 15 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 16 is to install the necessary power wiring to the starter.
c. VARIABLE FREQUENCY DRIVES: Physically mount all VFD's which are not specified to be installed on Division 15 factory assembled equipment. Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 15. Where disconnects are installed between a VFD and a motor provide the interlocking wiring between the disconnect and VFD to insure that the drive is shutdown simultaneously with motor.
d. DISCONNECTS: Provide all disconnects necessary for Division 15 mechanical equipment which are not provided as part of factory wired Division 15 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
e. CONTROLS: Division 16 Contractor is responsible for providing power to control panels and control circuit outlets.
f. FIRE AND LIFE SAFETY EQUIPMENT:
1) Fire Sprinkler System: Division 16 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.
2) Specialized fire suppression systems: Division 16 is responsible for providing power wiring to suppression system and its controls.

2. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
4. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.8 PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Section 09900: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, ductwork, equipment, insulation, steel, etc. Exposed gas piping inside and outside the building shall be painted with two coats of "Rust-O-Leum" Yellow. The inside surface of visible ductwork above diffusers/grilles shall be painted flat black. Exposed copper indirect waste piping serving food service equipment shall be painted metallic chrome.

B. All exposed work under Division 15 shall receive either a factory finish or a field prime coat finish, except:
1. Exposed copper piping.
2. Aluminum jacketed outdoor insulated piping.

3.9 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
2. Locate pipe markers as follows:
   a. Near each valve and control device.
   b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
   c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
   d. At access doors, manholes, and similar access points which permit view of concealed piping.
   e. Near major equipment items and other points of origination and termination.
   f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room. Vertically spaced at each story transversed.

C. Ductwork Identification: A minimum of every 20 feet for all ductwork 12 inch or more in diameter or width.

D. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
1. Main control and operating valves, including safety devices.
2. Meters, gauges, thermometers, and similar units.

3. Fans, blowers, primary balancing dampers, and mixing boxes.
4. Packaged HVAC central-station and zone-type units.
5. Sprinkler and standpipe equipment.

E. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

3.10 VIBRATION AND DYNAMIC BALANCING

A. Vibration tolerances shall be as specified by the "International Research and Development Corporation", Worthington, Ohio, measured by the displacement, peak to peak, as follows:
1. All Fans: Below severity chart labeled "FAIR", maximum velocity of 0.0785 in/sec, peak.
2. Pump and Electric Motors: Below severity chart labeled "SLIGHTLY ROUGH", maximum vibration velocity of 0.157 in/sec, peak.
3. Compressors: Same as pumps.

B. Correction shall be made to all equipment which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.11 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Ductwork: Test all air quantities as specified in Section 15990 - Testing, Adjusting and Balancing. Pressure tests per SMACNA.

C. Registers and Diffusers: Test for proper operation of manually operated control feature. Test all air quantities as specified in Section 15990 – Testing, Adjusting and Balancing.

D. Ductwork Specialties: Test all operable ductwork specialties for proper operation. Check all fire, smoke and fire/smoke dampers to ensure that they are 100% open.

E. Temperature Control: Test all control functions to assure that all systems are controlling as specified or as otherwise necessary and that all controls are adjusted to maintain proper room temperatures. The manufacturer's representative shall perform all tests.

END OF SECTION 15050

SECTION 15080
MECHANICAL INSULATION

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 1 - General Requirements, and Section 15050 - Basic Materials and Methods, and other Sections in Division 15 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
   1. Ductwork
      a. All supply air ductwork, unless otherwise shown on drawings.
      b. All return air ductwork, unless otherwise shown on drawings.
      c. Acoustical duct lining, in vertical/horizontal supply and return ducts within twenty feet (20') of air handling equipment and where otherwise shown on drawings.
      d. Vapor/moisture ductwork.
      e. Insulation to protect fire rated exhaust systems
   2. Piping:
      a. Domestic hot water supply and return piping.
   3. Plumbing:
      a. Condensate drains inside the building from cooling coil drip pans to discharge point.
      b. Horizontal pipe runs from fixtures receiving cold condensate from cooling coils, cold boxes, and ice machines.
      c. Drains from electric drinking fountains to first connection

B. Types of mechanical insulation specified in this Section include the following:
   1. Fiberglass duct insulation.
   2. Insulation jackets.
   3. Insulation accessories.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15050: Basic Materials and Methods.

B. Section 15400: Plumbing.

1.4 DEFINITIONS

A. Ambient: The air temperature to be maintained in a conditioned room. Typically between 70°F and 78°F.

B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.

C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.

D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.

E. Jacket: Protective covering over the pipe insulation; may be factory applied such as "all service jacket" or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.

F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.

G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.

H. Freezing Climate: Where outdoor design temperature is less than 33° F, as stated in ASHRAE fundamentals under 99% column for winter design conditions.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:
1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
   a. B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plat.
   b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
   c. C167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
   d. C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission.
   e. Properties by Means of the Guarded-Hot-Plate Apparatus.
   f. C195 - Specification for Mineral Fiber Thermal Insulating Cement.
   g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
   h. C302 - Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
   i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation.
   j. C305 - Test for Thermal Conductivity of Pipe Insulation.
   k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
   l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation.
   m. C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
   n. C449 - Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
   o. C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   p. C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
   q. C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   r. C547 - Specification for Mineral Fiber Preformed Pipe Insulation.
   s. C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation.
   t. C553 - Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
   u. C592 - Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).
   v. C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
   w. C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
   x. C921 - Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
   y. C1104 – Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
   z. C1071 - Standard Specification for Thermal and Acoustical Insulation.
   aa. C1338 – Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
   bb. E84 - Test Method for Surface Burning Characteristics of Building Materials.

cc. E119 - Test for Fire Resistance.
dd. G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
ee. G22 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
   a. 90 Energy Conservation in New Building Design.
3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
   a. 255 Test Methods, Surface Burning Characteristics of Building Materials.

B. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

C. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

D. Corrosiveness: Provide insulation such that when tested in accordance with the following test, the steel plate in contact with the insulation shows no greater corrosion than sterile cotton in contact with a steel plate for comparison.
   1. Test Specimen: Two specimens shall be used, each measuring 1" by 4" by approximately ½" thick.
   2. Apparatus: Provide a humidity test chamber in which two polished-steel test plates, 1" wide, 4" long and 0.020" thick, shall be placed. Plates shall be clear finish, cold-rolled strip steel, American quality, quarter hard, temper No. 3, weighing 0.85 lb/sq. ft.
   3. Procedure: The steel test plates shall be rinsed with cp benzol until their surfaces are free from oil and grease and allowed to dry. One piece of cold-rolled steel shall be placed between the two insulation specimens and secured with tape or twine. The test specimen and uncovered plate shall be suspended vertically in an atmosphere having a relative humidity of 95% (plus or minus 3%), and a temperature of 120°F (plus or minus 3°F), for 96 hours, and then be examined for corrosion.

E. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also furnish necessary test data certified by an independent testing laboratory. Submit samples.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Johns Manville, Owens-Corning, or Certainteed. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.2 DUCTWORK INSULATIONS

A. Flexible Fiberglass Blanket: Johns Manville Microlite Xc, formaldehyde-free Type 75 Flexible Blanket:
1. Application: Insulation wrap for ductwork, or other HVAC systems.
2. 'K' Value: ASTM C553-92, 0.27 Btu•in./(hr•ft²•°F) at 75°F installed full thickness.
3. Density: 0.75 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft.
5. Installation: See Part 3 below.

B. Rigid Fiberglass Board: Johns Manville Linacoustic R-300, Type II duct board:
1. Application: Lining insulation for HVAC plenums and ductwork.
2. 'K' Value: ASTM C1071, 0.23 Btu•in./(hr•ft²•°F) at 75°F.
3. Density: 3.0 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft.
5. Installation: See Part 3 below.

C. Fiberglass Duct Liner: Johns Manville Linacoustic R-300, RC, or HP with Anti-Microbial Treatment.
1. Application: Duct lining for acoustic or thermal purposes.
2. 'K' Value: ASTM 1071, 0.23 Btu•in./(hr•ft²•°F) at 75°F.
3. Noise Reduction Coefficient: 0.65 or higher based on "Type A mounting."
4. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
5. Adhesive: UL listed waterproof type compliant with ASTM C916.
6. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

D. Round Duct Liner: Johns Manville Spiracoustic Plus; with Anti-Microbial Treatment.
1. Application: Round duct lining for acoustic or thermal purposes.
2. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft²•°F) at 75°F.
3. Noise Reduction Coefficient: 0.70 as per ASTM C427. (Type A mounting.)
4. Maximum Velocity: 4,000 ft/min.

E. Field Applied Jackets (For Exterior Applications):
1. Longitudinal seams shall not be located on top of ducts when exposed to outdoor environment.
2. Stainless Steel Jacket: Type 304 stainless steel, 0.010" minimum (smooth/corrugated) finish.
3. Aluminum Jacket: 0.016" aluminum with factory applied moisture barrier positioned such that the longitudinal overlap provides a watershed.
4. Circumferential joints shall be wide enough to provide weather-proofing jacket.

5. Secure jacket with ⅜" or ½" stainless steel bands on 12" centers.

F. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of ductwork
2. PVC Plastic: Johns Manville Zeston 2000. One piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape.

2.3 FIRE-RATED INSULATION SYSTEMS

A. Insulation for Type I, commercial, kitchen hood exhaust ductwork. (See also Section 15880 Air Distribution referencing this Section).

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.
1. Products:
a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Thermal Ceramics; FireMaster Duct Wrap.
d. 3M; Fire Barrier Wrap 20A.

2.4 PIPE INSULATIONS

A. Glass Fiber: Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
1. Non-Wicking:
a. Manufacturers:
1) Johns Manville Micro-Lok Meeting ASTM C547; or Micro-Flex (pipe sizes larger than 18")
2) Knauf
3) einsulation
b. Applications: Insulation of piping up to 18" in diameter and 3" thick insulation.
c. 'K' Value: 0.23 at 75°F.
d. Maximum Service Temperature: 850°F.
e. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.
2. Wicking: Owens Corning VaporWick Meeting ASTM C547; Rigid Molded Noncombustible:
a. 'K' Value: 0.23 at 75°F.
b. Maximum Service Temperature: 850°F.
c. Jacket: Polymer facing with factory-applied adhesive closure to provide positive mechanical and vapor sealing of longitudinal seams.

B. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of pipes.
2. PVC Plastic: Johns Manville Zeston 2000. One piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape.
3. Canvas Jacket: UL listed fabric, 6 oz/sq. yd. plain weave cotton, treated with dilute fire retardant lagging adhesive.
4. Aluminum Jacket: 0.016" thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
5. Secure aluminum jackets with 3/8" or ½" stainless steel bands on 12" centers.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that piping and ductwork has been tested for leakage in accordance with specifications before applying insulation materials. All piping and ductwork shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. General:
1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
2. Remove and replace any insulation that has become wet or damaged during the construction process.
3. Continue insulation and vapor barrier at penetrations and duct supports, except where prohibited by code. Instances where this is required include:
   a. Ductwork support angle or struts. To prevent crushing of low density insulation, provide separator or high density insulation at point of support. Vapor barrier to continue unbroken at point of support.

B. Ductwork –Insulation on the Duct Exterior:
1. Provide insulated ductwork conveying air below ambient temperature (below room temperature) with vapor retardant jacket. Seal all vapor retardant jacket seams and penetrations with UL listed tapes or vapor retardant adhesive.
2. Provide insulated ductwork conveying air above ambient temperature (above room temperature) with or without vapor retardant jacket. Where service access is required, bevel and seal ends of insulation.
3. All exposed exterior metallic ductwork exposed or covered with cladding is to be built with a crown to shed moisture.
4. Continue insulation through walls, sleeves, hangers, and other duct penetrations except where prohibited by code.
5. The insulation shall be firmly wrapped around the ducts with all joints lapped a minimum of 2". The vapor barrier shall be sealed with FSK or metallic pressure sensitive tape. Installed thickness shall not exceed 25% compression. Secure insulation with 16 gage soft annealed black or galvanized wire spaced not more than 12" on centers for straight runs of duct and 6" on centers for elbows and fittings.
6. The underside of duct work 24" or greater in width shall be secured with mechanical fasteners and speed clips spaced approximately 18" on center. The protruding ends of the fasteners shall be cut off flush after the speed clips are installed, and then, when required, sealed with the same tape as specified above.
7. For ductwork exposed in mechanical equipment rooms below 7' or in finished spaces, finish with Johns Manville Zeston 2000 PVC jacket or aluminum or stainless steel jacket.
8. For interior vapor/moisture duct applications, install fiberglass insulation unless specifically indicated otherwise on drawings. Install to meet manufacturer's requirements and as required by local code authorities.
9. For exterior applications, provide insulation with a weather protection jacket.
10. For exterior vapor duct applications, install fiberglass insulation with weatherproof jacket.

C. Grease Ducts:

1. For grease ducts inside the conditioned building envelope but not in rated enclosures, install two-hour fire rated blanket wrap system to meet manufacturer's requirements and as required by NFPA and local code authorities.

D. Duct Liner:

1. Adhere insulation to sheet metal with a UL listed adhesive. Adhesive shall be applied to the sheet metal with a minimum coverage of 90%.
2. Secure insulation with mechanical liner fasteners as indicated by SMACNA or manufacturer. Pin length should be as recommended by the liner manufacturer.
3. All exposed edges of the liner must be factory or field coated. Unless factory coated, all transverse edges and longitudinal joints of the duct liner shall be coated. For systems operating at 4,000 fpm or higher, a metal nosing must be installed in all liner leading edges.
4. Repair liner surface penetrations with UL listed adhesive.
5. Duct dimensions indicated on plans are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

E. Piping Insulation:

1. Locate insulation and cover seams in least visible locations unless otherwise specified.
2. Neatly finish insulation at supports, protrusions, and interruptions.
3. Provide insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps. Insulate complete system.
4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Bevel and seal ends of insulation at equipment, flanges, and unions.
5. Provide insert between support shield and piping on piping 1½" diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
   a. 1½" to 2½" pipe size — 10" long
   b. 3" to 6" pipe size — 12" long
   c. 8" to 10" pipe size — 16" long
   d. 12" and over — 22" long
6. Use of metal saddles is acceptable as specified in Section 15050. Fill interior voids with segments of insulation matching adjoining pipe insulation.
7. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Klo-Shure coupling or equal.
8. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers, or aluminum or stainless steel jacket.
9. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of premolded covers or lace-on type insulation blankets is required.
10. For exterior applications:
    a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
    b. Apply weather-resistant protective finish such as WB Armaflex to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armaflex 520 BLV adhesive.
11. For underground installations, install per manufacturer's written instructions and recommendations.

12. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

3.3 DUCTWORK INSULATION SCHEDULE

A. All insulation thicknesses shall meet or exceed state energy code and mechanical code requirements as noted below. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior "K" factors.

B. All air distribution system ducts and plenums, but not limited to, building cavities, mechanical closets, air handler boxes, and support platforms uses as ducts or plenums, shall be installed, sealed , and insulated to meet the requirements of the code. Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum level of R-8.
1. In a space between the roof and an insulated ceiling.
2. In a space directly under a roof with fixed vents or opening to the outside or unconditioned spaces
3. In an unconditioned crawlspace.
4. In other unconditioned spaces.

C. Flexible Fiberglass

	THICKNESS (inches)	FINISH	REMARKS
Supply ducts within building envelope	1-1/2	FSK	
Supply or return duct installed as exposed ductwork in the occupied space.	0		Except where noted on drawings for acoustical reasons
Return ducts within building envelope	1-1/2	FSK	
Exterior/Outside supply and return ductwork sandwiched in double wall sheetmetal	2-1/2 *	FSK	* or a thickness resulting in compressed R value=8
Supply and return ductwork located as described in 3.3.B above.	2		
Exhaust ducts within 10 ft. of exterior openings	2	FSK	
Exhaust ducts and ventilation equipment casing exposed to outdoor air	2	FSK	

D. Thicknesses in the above table shall have insulation values as follows: 1 1/2 " = R-6, 2" = R-8.0, 3" = R-12. Greater thicknesses are permitted to achieve identical values if space constraints allow.

E. Rigid Fiberglass

	THICKNESS (inches)	FINISH	REMARKS
Outside air intake ducts	1-1/2	FSK	

F. Duct Liner:

	THICKNESS	FINISH	REMARKS

	(inches)		
Where indicated	1" unless otherwise noted on plans	Linacoustic	
Within 20' of Air Handling Unit in supply and return ducts	1	Linacoustic	

G. Duct Liner (round):

	THICKNESS (inches)	FINISH	REMARKS
Where indicated	1	Spiracoustic	

3.4 PIPING INSULATION SCHEDULE

A. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness ½" if exposed to exterior ambient air. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior "K" factors.

B. Fiberglass Insulation

	PIPE SIZE (inches)	THICKNESS (inches)	REMARKS
Domestic hot water	Up to 2	1	
	2 ½ and over	1 ½	
Domestic hot water return	All Sizes	1	
Condensate piping	All Sizes	1	
Misc. drains from electric water coolers, ice machines, etc.	All Sizes	1	

END OF SECTION 15080