

## SECTION 200000 - MECHANICAL GENERAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Supplemental requirements in addition to Division 1 - General Requirements applicable to all Divisions 20, 21, 22, 23, 25 - Mechanical specification sections.
- B. Related Sections:
  - 1. 019100 - Commissioning
  - 2. 200513 - Common Motor Requirements
  - 3. 200529 - Mechanical Hangers and Supports
  - 4. 200548 - Mechanical Vibration and Seismic Control
  - 5. 200553 - Mechanical Identification
  - 6. 200556 - Interior Trench Excavation and Backfill
  - 7. 200700 - Mechanical Insulation
  - 8. 211000 - Water Based Fire Suppression Systems
  - 9. 213000 - Fire Pumps
  - 10. 221100 - Domestic Water Piping and Specialties
  - 11. 221300 - Sanitary Waste and Vent Piping and Specialties
  - 12. 224000 - Plumbing Fixtures
  - 13. 230593 - Testing, Adjusting and Balancing
  - 14. 231113 - Fuel Oil Piping and Specialties
  - 15. 231323 - Aboveground Fuel Oil Storage Tanks
  - 16. 232113 - Hydronic Piping and Specialties
  - 17. 232123 - Hydronic Pumps
  - 18. 233100 - Ducts and Accessories
  - 19. 233400 - HVAC Fans

20. 233600 - Air Terminal Units
21. 233700 - Air Outlets and Inlets
22. 235100 - Breechings, Chimneys and Stacks
23. 235223 - Cast Iron Boilers and Accessories
24. 236400 - Packaged Water Chillers
25. 237323 - Central Air Handling Units
26. 238123 - Dedicated Air-Conditioning Units
27. 238200 - Terminal Heating and Cooling Units
28. 238316 - Radiant Floor Heating Equipment
29. 253000 - Building Automation System Field Devices
30. 254000 - Variable Speed Drives
31. 255000 - Building Automation System
32. 259000 - Sequence of Operations

## 1.2 REFERENCES

### A. Codes and Standards:

1. Perform work in accordance with the legally enacted editions of applicable international, state and local codes with locally accepted amendments to include:
  - a. 2012 International Building Code (IBC).
  - b. 2012 International Mechanical Code (IMC).
  - c. 2015 Uniform Plumbing Code (UPC).
  - d. 2012 International Fire Code (IFC).
  - e. 2014 NFPA 70, National Electric Code (NEC).
  - f. Standard for Accessible and Usable Buildings and Facilities (ANSI A117.1-2009).
2. Standards: Reference to the following standards infers that installation, equipment and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:
  - a. American Gas Association - AGA.
  - b. American National Standards Institute - ANSI.
  - c. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE.
  - d. American Society of Mechanical Engineers - ASME.
  - e. American Society for Testing and Materials - ASTM.
  - f. National Electrical Manufacturers' Association - NEMA.

- g. National Fire Protection Association - NFPA.
- h. Sheet Metal and Air Conditioning Contractors National Association, Inc. - SMACNA.

B. Definitions:

1. "Accessible" means arranged so that an appropriately dressed man 6'-2" tall, weighing 250 pounds, may approach the area in question with the tools and products necessary for the work intended; and may then position himself to properly perform the task to be accomplished, without disassembly or damage to the surrounding installation.
2. "Authority Having Jurisdiction" is the individual official, board, department, or agency established and authorized by the political subdivision created by law to administer and enforce the provisions of the Code as adopted or amended.
3. "As Specified" denotes a product, system, or installation that:
  - a. Includes salient characteristics identified in the Drawings and Specifications.
  - b. Meets the requirements of the "Basis of Design".
  - c. Is produced by a manufacturer listed as acceptable on the Drawings or in the Specifications.
4. "Basis of Design" refers to products around which the design was prepared. Some or all of the particular characteristics of Basis of Design products may be critical to the fit or performance of the completed installation. Such characteristics are often subtle. Where substitutions are made to products that are the Basis of Design, the Contractor is alerted that nominally acceptable substitutions may produce undesirable side effects such as products that no longer fit the space due to increased product dimensions. The Contractor is responsible for resolving impacts of substitutions. Approval of a substitution request does not relieve the Contractor of complying with the design intent and applicable Codes. Reference to a specific manufacturer's product (even as "Basis of Design") does not necessarily establish acceptability of that product without regard to compliance with other provisions of these specifications.
5. "Contracting Agency" is the Owner as defined in the General Conditions of the Contract.
6. "Demolish" means to permanently remove a component, equipment, or system and its appurtenances with no intent for reuse and to properly disposal of it.
7. "Furnish" means to purchase material as shown and specified, and cart the material to an approved location at the site or elsewhere, as noted or agreed, to be installed by supporting crafts.
8. "Install" means to set in place and connect, ready for use and in complete and properly operating finished condition, material that has been furnished.
9. "Product" is a generic term that includes materials, equipment, fixtures and any physical item used on the project.
10. "Provide" means furnish products, labor, subcontracts, and appurtenances required and install to a complete and properly operating, finished condition.

11. "Remove" means to remove a component, equipment, or system and its appurtenances and either store it for re-installation/reuse, or turn it over to the Contracting Agency.
12. "Rough-in and Connect" means provide an appropriate system connection such as water services with stops, continuous wastes with traps, shutoff valves, and piping connections, testing, etc., for proper operation, ready for furnished products to be installed. Equipment furnished is received, uncrated, assembled and set in place by supporting crafts unless prior arrangements are made to hire the rough-in installer for this work.
13. "Serviceable" means arranged so that the component or product in question may be properly removed and replaced without disassembly, destruction or damage to the surrounding installation. "Serviceable" components shall be "accessible".
14. "Shop Drawings" are dimensioned working construction drawings drawn to scale to show an entire area of work in sufficient detail to demonstrate service and maintenance clearances and coordination of all trades.
15. "Substitution" is a product, system or installation that is not by a listed manufacturer or does not conform to all salient characteristics identified in the Project Manual, but that the Contractor warrants meets specific requirements listed in the Project Manual.
16. "System Drawing" is a diagrammatic engineered drawing that shows the interconnection and relationship between products to demonstrate how the products interact to accomplish the function intended. Examples of system drawings include plumbing diagrams, control and instrumentation diagrams, and wiring diagrams. Some drawings, such as dimensioned and complete Fire Suppression Drawings may be both System Drawings and Shop Drawings.

### 1.3 SYSTEM DESCRIPTION

#### A. Performance Requirements:

1. Provide labor, products and services required for the complete installation, checkout, and startup of mechanical systems shown and specified. Coordinate related work, including the work of other crafts, to provide each system complete and in proper operating order.
2. Cooperate with others involved in the project; with due regard to their work, to promote rapid completion of the entire project.
3. Become thoroughly familiar with the local conditions under which the work is to be performed. Schedule work with regard to seasons, weather, climatic conditions, and other local conditions that may affect the progress and quality of the work.
4. In general, the mechanical, electrical and building automation systems are interrelated. Coordinate the interface and operation of systems so that interrelated systems operate in proper synchronization and balance.
5. Provide labor, materials, and equipment to facilitate the commissioning process of systems and equipment within this scope of work. Perform tests and verification procedures required for the commissioning process as requested by the Contracting Agency.

#### 1.4 PREINSTALLATION MEETINGS

- A. Meet with and coordinate Divisions 20, 21, 22, 23, 25 work with the interrelated work of other trades including Architectural, Civil, Structural, and Electrical to identify and resolve potential conflicts.

#### 1.5 SUBMITTALS

- A. Refer to Division 1 for general submittal requirements for the items listed below, supplemented with the additional requirements listed. In addition, prepare Divisions 20, 21, 22, 23, 25 submittals in accordance with the following.

- B. General:

1. The Contracting Agency's obligation to review submittals and to return them in a timely manner is conditioned upon the prior review and approval of the submittals by the Contractor as required by the Construction Contract.
2. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Project Manual.
  - a. Submittals will not be checked for quantity, dimension, fit, or for proper technical design of manufactured equipment.
  - b. Provision of a complete and satisfactory working installation is the responsibility of the Contractor.
3. Furnish suppliers with the applicable portions of the Project Manual and review and verify that the suppliers' submittals clearly represent products which comply with the Project Manual.
4. Master Submittal Log]
  - a. Create and maintain a master submittal log for items submitted in Divisions 20, 21, 22, 23, 25, including test results, certifications, record drawings, etc.
  - b. Submit master submittal log, independent of other submittals, as the first submittal for review and approval by the Contracting Agency.
  - c. Update submittal log with each submittal action.
  - d. Share an electronic copy with Contracting Agency and Engineer at two week intervals, or as requested by the Contracting Agency.

- C. Coordination:

1. Prior to a submittal's submission for approval, hold a meeting of all construction trades to review shop drawings and submittals. Each trade shall cross-check shop drawings and submittals for conflicts, clearances, physical space allocation and routing, discrepancies, dimensional errors, omissions, contradictions, departures from the Contract requirements, correct electrical/mechanical services and connections, and provisions for commissioning.
2. Review, revise, correct, and appropriately annotate submittals prior to submission for approval.

3. Keep a current copy of approved submittals and the submittal log at the job site.

D. Electronic Submittals:

1. Provide electronic submittals in PDF format in addition to hard copy submittal. Maximum file size to be coordinated with Contracting Agency.
2. Follow the organization and formatting required for paper submittals.
3. Provide electronic bookmarks within the PDF document in place of tabs and sub-tabs.
4. If individual PDF files are provided for a product or shop drawing sheet(s), organize files into folders and name files and folders to correspond with applicable specification sections or drawing titles.
5. Create PDF documents without security, to be searchable, and to allow copy and paste. For scanned documents, run the optical character recognition (OCR) function to ensure the document is searchable and can be copied and pasted.
6. Reduce PDF file size by removing data and file creation elements not needed for final file presentation.

E. Product Data:

1. General:
  - a. This section describes in detail the preparation of mechanical product submittals. Submittals not provided as described shall be rejected without review. This procedure is designed to accelerate and improve the accuracy of the technical review process, as well as, simplify the preparation of the Installation, Operation, and Maintenance Manuals (IO&Ms).
  - b. Product data for each specification section shall be submitted in one complete package, except as noted in this section.
2. Submittal Organization:
  - a. Organize product submittal information in the same order as the products are specified. Provide a separate tabbed divider for each Divisions 20, 21, 22, 23, 25 specification section. Provide the typed section number on each tab.
  - b. Within each section, organize product information in the same order as products are specified in Part 2 of each applicable specification section. Provide sub-tabs within each section for each separate product article. Provide the typed product article number on each tab.
  - c. Provide product submittal information for each product specified in 8-1/2" x 11" format. Fold-out 11" x 17" format is also acceptable.
  - d. If a particular specified product is being omitted from the product submittal or will not be used for the project, provide a single sheet within the article tab identifying the product and annotated with a brief reason why the product is not being submitted, for example: "NOT USED," NO SUBMITTAL REQUIRED," "TO BE SUBMITTED BY (PROVIDE DATE)," etc. This will inform the reviewer that the product was not overlooked.

- e. Partial submittals from individual subcontractors may be provided which cover a particular sub-contractor's scope of work. In this case, arrange partial submittals by system classification such as: PLUMBING, HEATING, FIRE SUPPRESSION, VENTILATION, BUILDING AUTOMATION SYSTEM, etc. Within each system classification, arrange product submittals by specification section, as described, such that each specification section can easily be reorganized into a master set of Divisions 20, 21, 22, 23, 25 product submittals organized by specification section. This will greatly simplify the preparation of IO&M manuals as described below.
  - f. Bind product submittal information in identical 3 inch wide, hard-backed, loose-leaf, 3 ring binders with clear front and spine insert pockets. Divide information into multiple volumes so that the pages in each binder rest naturally on one side of rings.
  - g. Provide a master table of contents at the front of each volume which lists the Divisions 20, 21, 22, 23, 25 specification sections and indicates which sections are located within each volume.
  - h. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
  - i. Provide identical cover and spine inserts for each product submittal volume, to include the following typed information:
    - 1). The Contracting Agency Name.
    - 2). Project Name.
    - 3). Contractor Name.
    - 4). Subcontractor Name preparing the submittal.
    - 5). Date that the submittal or resubmittal was initiated.
    - 6). "Mechanical Product Submittals" or "Plumbing Product Submittals" etc. as appropriate.
    - 7). "Volume 1 of X, Volume 2 of X," etc.
3. Product Information:
- a. Indicate manufacturer's name and address, and local supplier's name, address, phone number.
  - b. Indicate each product as "Basis of Design", "Specified Equal" or "Proposed Substitution."
  - c. Identify catalog designation and/or model number.
  - d. Provide manufacturer's product literature. Neatly annotate to indicate specified salient features, appurtenances and performance criteria for each product specified to demonstrate compliance with the Project Manual to include scheduled information, drawing information and specified information.
  - e. Indicate product deviations from the Project Manual and mark out non-applicable items on generic "cut-sheets."
  - f. Include manufacturer provided dimensioned equipment drawings with rough-in mechanical and electrical connections.
  - g. Include operation characteristics, performance curves and rated capacities.
  - h. Include motor characteristics and wiring diagrams.
  - i. Include weight of equipment. Including accessories.
  - j. Provide basic manufacturer's installation instructions.
4. Product Substitutions:

- a. Clearly indicate both in the section table of contents and on the individual product submittal information each proposed substitution, deviation or change from the product as described in the Project Manual.
- b. Submittal approval does not include substitutions, deviations or changes from the requirements of the Project Manual unless they are specifically itemized and approved. The term "No Exceptions Taken" will not apply to substitutions, deviations or changes not clearly identified.
- c. Provision of a satisfactory working installation of equal quality to the system as described in the Project Manual shall be the responsibility of the Contractor.
- d. Correct unapproved deviations from the Project Manual discovered in the field as directed by and at no additional cost to the Contracting Agency.
- e. Cost of any design modifications as a result of proposed product substitutions shall be borne by the Contractor.

F. System Drawings:

1. Submit System Drawings for dynamic elements/systems of the project which are performance specified to include but not limited to: Fire Suppression Systems, Building Automation Systems and stand-alone packaged equipment.
2. Prepare system drawings on full sized sheets of the same size as the original construction drawings.
3. Include with each system a sequence of operation narrative which describes each mode of system operation in sufficient detail to demonstrate compliance with the Project Manual to the satisfaction of the Contracting Agency.

G. Shop Drawings:

1. General:
  - a. The Project Manual documents are not intended for nor are they suitable for use as shop drawings. Project Manual documents shall not be utilized for the actual fabrication or installation of products or equipment.
  - b. The Drawings are partly diagrammatic and do not show all offsets in piping or ducts, and may not show in minute detail all features of the installation; however, provide systems complete and in proper operating order.
  - c. Locations of products are approximate unless dimensioned.
  - d. Divisions 20, 21, 22, 23, 25 products and systems shall not be installed without shop drawings approved by the Contracting Agency.
  - e. Rework, changes or additional engineering support required as a result of the installation of products and systems prior to the approval of applicable shop drawings by the Contracting Agency shall be provided at the Contractor's expense.
  - f. Drawing symbols used for basic materials, equipment and methods are commonly used by the industry. Special items are identified by a supplementary list of graphical illustrations, or identified on the drawings or specifications.
2. Preparation:
  - a. Review each Divisions 20, 21, 22, 23, 25 specification section and identify the shop drawing requirements.



- b. Combine the shop drawing requirements first by system (i.e. ventilation system, heating system, plumbing system, etc.) and then by area (i.e. fan room, boiler room, etc.).
  - c. Prepare shop drawings on full sized sheets of the same size as the original construction drawings.
  - d. Arrange shop drawings to scale, showing dimensions where accuracy of location is necessary for coordination or communication purposes.
  - e. Incorporate the actual dimensions and configurations of the products and systems approved through the product submittal process into the shop drawings.
  - f. Provide dimensioned maintenance clearance areas around each product as recommended by the manufacturer.
  - g. Coordinate Divisions 20, 21, 22, 23, 25 work with the interrelated work of other trades including Architectural, Civil, Structural, and Electrical.
  - h. Identify and provide recommendations to resolve major conflicts which may impact the design of the systems as shown. Such conflicts will be resolved during the shop drawing review process.
  - i. Identify locations where field coordination between various trades is necessary to avoid conflicts.
  - j. Indicate elevation of piping, ductwork and equipment above or below finished floor at various locations and in sufficient detail to demonstrate clearance from structural elements and the work of other trades.
  - k. Coordinate placement of openings and holes through structure, walls, floors, ceilings, and roof with Structural and Architectural.
3. Submittal:
- a. Submit dimensioned shop drawings as specified to demonstrate proper planning and sequencing of the applicable trades for the installation and arrangement of Divisions 20, 21, 22, 23, 25 with respect to other interrelated work.
  - b. Partial shop drawings submittals (i.e. heating system only) will be rejected without review, as the interrelationship with other related work and overall system fit cannot be evaluated.
    - 1). Underslab shop drawings may be submitted separately for review to accommodate the construction schedule.
  - c. It is assumed that shop drawings submitted for review have been thoroughly prepared and coordinated and that the products and systems can and shall be installed as shown. Conflicts which are not clearly identified and annotated on the submitted shop drawings are assumed not to exist.
  - d. Installation conflicts arising from the failure to properly coordinate the work of related trades shall be provided at the Contractor's expense.

H. Certificates:

1. Review the submittal requirements for Certificates for each Divisions 20, 21, 22, 23, 25 specification section.
2. Submit copies of certificates as specified. This information may be included within the Installation, Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.

I. Test and Evaluation Reports:

1. Review the submittal requirements for Test and Evaluation Reports for each Divisions 20, 21, 22, 23, 25 specification section.
2. Submit copies of reports as specified. Also include these reports within the Installation, Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.

J. Installation, Operations and Maintenance (IO&M) Manuals:

1. Review the submittal requirements for IO&M manuals for each Divisions 20, 21, 22, 23, 25 specification section.
2. Begin the preparation of the mechanical IO&M manuals with a complete and fully approved set of mechanical product data submittals organized, annotated and with the product information as indicated within the "Product Data" submittals article above and in each Divisions 20, 21, 22, 23, 25 section.
3. Next, augment each individual product submittal with the written installation, operations and maintenance information for each approved product. This type of information is not applicable (or available) for bulk commodity or simplistic products such as copper pipe, basic pipe hangers or equipment tags, etc.
4. Annotate the installation, operations and maintenance information to indicate applicable information for the specific equipment model(s) installed.
5. Maintenance information shall include:
  - a. Preventive maintenance requirements for each product, including the recommended frequency of performing each preventive maintenance task.
  - b. Instructions for troubleshooting, minor repair and adjustments required for preventive maintenance routines, limited to repairs and adjustments that may be performed without special tools or test equipment and that require no extensive special training or skills.
  - c. Information of a maintenance nature covering warranty items, etc., that have not been discussed in the manufacturers' literature.
  - d. Information on the spare and replacement parts for each product and system. Properly identify each part by part number and manufacturer.
  - e. Recommended spare parts list.
6. Organize the IO&M manual information by specification section (not by sub-contractor) with a tabbed divider separating each section. Provide the typed section number on each tab.
7. Within each section, organize the product information in the same order as the products are specified in Part 2 of each applicable section. Provide sub-tabs within each section for each product. Provide the typed product article number on each tab.
8. Bind the information in identical 3 inch wide; hard-backed, loose-leaf, 3 ring binders with clear front and spine insert pockets. Divide information into multiple volumes so that the pages in each binder rest naturally on one side of rings.

9. Provide a master table of contents at the front of each volume which lists the Divisions 20, 21, 22, 23, 25 specification sections and indicates which sections are located within each volume.
10. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
11. Provide identical cover and spine inserts for each IO&M manual volume, to include the following typed information:
  - a. The Contracting Agency Name.
  - b. Project Name.
  - c. "Mechanical Installation, Operations and Maintenance Manual".
  - d. "Volume 1 of X, Volume 2 of X," etc.
12. Submit copies of Operation and Maintenance Manuals in electronic format (Adobe PDF).

## 1.6 CLOSEOUT SUBMITTALS

### A. Warranty Documentation:

1. Review the manufacturer's warranty requirements for each Divisions 20, 21, 22, 23, 25 specification section.
2. Submit required warranty documentation to the applicable Manufacturer's Representative to validate standard manufacturer's warranty for each required product. Obtain written confirmation of receipt from each applicable Manufacturer's Representative.
3. Provide Contracting Agency one copy of submitted warranty documentation and written confirmation of receipt for each applicable Manufacturer's Representative. This information may be included within the Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.
4. Provide statement of Contractor's warranty of workmanship, labor, and materials, as described under Article 1.12 Warranty below.

### B. Record Documentation:

1. General: As the Work progresses, neatly annotate a designated and otherwise unused set of Divisions 20, 21, 22, 23, 25 Contract Drawings to show the actual locations and routing of Divisions 20, 21, 22, 23, 25 Work and the terminal connection points to related Work. As a minimum, include the following:
  - a. Annotate record drawings to incorporate each applicable addendum.
  - b. Annotate record drawings as directed by each applicable Request for Information (RFI) and accepted Change Order Proposal.
  - c. Modify record drawings to show actual equipment sizes and locations and pipe and duct routing. Revise pipe and duct sizes as appropriate.
  - d. Provide dimensioned locations for permanently concealed piping and ductwork (i.e. piping cast in concrete or buried underground/underslab).

- e. Show the actual locations of system isolation valves, especially valves which are concealed above ceilings and behind access panels.
2. Preparation:
    - a. Neatly annotate record drawings to provide clear interpretation to support electronic drafting by a third party.
    - b. Tape electronic sketches from addendums and/or RFIs directly to the record drawings as overlays.
    - c. Annotate the record drawings in colored pencil using the same symbols and abbreviations as indicated in the Divisions 20, 21, 22, 23, 25 legends and schedules of the Contract Drawings.
      - 1). Red to add information.
      - 2). Green to delete information.
      - 3). Blue to provide additional clarifying information which is not to be drafted.
    - d. After submittal to the Contracting Agency, provide additional clarification, information or rework as necessary to support the accurate interpretation and electronic drafting of the record drawings.
  3. Submittals:
    - a. Provide dimensioned underslab record drawings to the Contracting Agency prior to placing the slab. For slabs placed in multiple sections, provide record drawings for the applicable slab sections to the Contracting Agency prior to each pour.
    - b. Provide complete record drawings for concealed areas (i.e. above lay-in and hard ceilings and inside walls) to the Contracting Agency prior to concealment.
    - c. Provide the remaining portion of the record drawings for exposed areas to the Contracting Agency prior to the final completion of the project.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

### A. Spare Parts:

1. Furnish spare parts for systems and equipment as listed in applicable sections of Divisions 20, 21, 22, 23, 25.
2. Clearly label each part with name, manufacturer's part number, system and/or equipment where used and location.
3. Deliver parts to location and person designated by the Contracting Agency, in durable storage boxes.
4. Group cartons containing smaller items by system or application and deliver in an appropriate number of storage boxes.

- B. Tools: Provide three sets of special tools and testing and monitoring equipment as listed in applicable sections of Divisions 20, 21, 22, 23, 25.

## 1.8 QUALITY ASSURANCE

### A. Qualifications:

1. Manufacturers: Companies specializing in manufacturing the Products specified in the Divisions 20, 21, 22, 23, 25 sections with documented experience.
2. Fabricators: Companies specializing in fabricating the Products specified in the Divisions 20, 21, 22, 23, 25 sections with documented experience.
3. Installers: Perform the Work using qualified workmen that are experienced and usually employed in the trade.
4. Testing Agencies: Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and as indicated.

### B. Product Testing and Certification:

1. Nationally Recognized Testing Laboratory (NRTL) Labeling: Electrical equipment and conductors shall be "Approved," "Certified," "Identified," or "Listed" and "Labeled" to establish that the electrical equipment is safe, free of electrical shock and fire hazard, and suitable for the purpose for which it is intended to be used. The manufacturer shall have the specific authorization of one of the Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratories (NRTLs) in accordance with the applicable national standards to label the equipment as suitable.
2. Where the words Listed, UL Listed, UL Labeled, Underwriters Laboratories, Inc., UL, or variations of this terminology, appear under this Division of the Specifications or the associated drawings, it is understood that a comparable testing agency as defined by NRTL above is acceptable.
3. Such testing and certification is generally applicable to products within the following categories:
  - a. Life safety and fire suppression.
  - b. Fuel burning equipment, except certain classes of power or industrial equipment for which other recognized certification applies as well.
  - c. Factory fabricated and wired electrical control panels and packaged equipment with factory installed electrical controls or panels.
  - d. Components for life safety systems, fuel systems and medical gas systems.
4. The listing under Paragraph '3' above is provided for illustration of requirements and is not exclusive. Provide products that have been tested and listed for the intended application when such products are available unless the Contracting Agency has provided written exemption on an itemized basis.
5. Provide electrical products listed and labeled by UL, FM, ETL or other approved NRTL. If listing and labeling is not available, stamp the submittal for these products by an Alaska Registered Professional Engineer approved by the Authority Having Jurisdiction, at no additional cost.

6. Where interpretation is required, the Contracting Agency will provide direction and will be the sole judge in cases of compliance with this subsection.

#### 1.9 DELIVERY, STORAGE AND HANDLING

##### A. Delivery and Acceptance Requirements:

1. Verify products are new and delivered in original factory packaging/crating and are free from damage and corrosion.
2. Replace products delivered to job site that does not comply with above requirements at no expense to Owner.
3. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

##### B. Storage and Handling Requirements:

1. Store products in covered storage area protected from the elements, outside the general construction area until installed.
2. Store products in original factory packaging until actual installation.
3. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
4. Replace damaged items with same item in new condition.

#### 1.10 WARRANTY

- A. See Division 1 for general warranty requirements.
- B. Warranty workmanship, labor, and materials for a period of one year from the date of final acceptance, without limitation, except where longer warranty periods are specified in a specific Section under this Division, or in the General Conditions of the Contract. Promptly coordinate and perform Warranty work at the Contractor's sole expense.

#### PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Cover and protect open ends and individual components of the ventilation and piping systems during construction when dust, dirt, debris, overspray, or other potential construction contaminants could enter the air distribution system or elements (ducts, fans, VAV boxes, silencers, etc.).
2. Provide temporary construction filters over return airshaft openings and at air handling unit return air dampers.

3.2 INSTALLATION

A. Special Techniques:

1. Provide temporary heating to maintain the building at 65 degrees F.
2. Provide temporary ventilation with filtration during construction.

B. Interface with Other Work:

1. Electrical Work:

- a. Coordinate with Division 26.
- b. See also specification section 200513 - Common Motor Requirements.
- c. Suggested Coordination Schedule: The Contractor is responsible to provide heating, ventilating, and plumbing equipment motors and controls, including fire suppression controls. Unless otherwise indicated on the Drawings, it is recommended that motors and controls be furnished, set in place, and wired in accordance with the following schedule. "CC" applies to either a Control subcontractor working as a sub to the General Contractor or to the Divisions 20, 21, 22, 23, 25 Mechanical subcontractor. Coordinate work between subcontractors.

MC - Divisions 20, 21, 22, 23, 25-Mechanical CC - Divisions 20, 21, 22, 23, 25-Controls EC - Divisions 26, 27 and 28-Electrical	Furnished By	Set in Place By	Power By	Control By
Equipment Motors	MC	MC	EC	CC
*Magnetic motor starters:				
Automatic controlled, w/ or w/o HOA switches	EC	EC	EC	CC
Automatic controlled, w/ or w/o HOA switches, and that are furnished as part of factory wired equipment	MC	MC	EC	MC
*Manual Motor Starters:				

MC - Divisions 20, 21, 22, 23, 25-Mechanical CC - Divisions 20, 21, 22, 23, 25-Controls EC - Divisions 26, 27 and 28-Electrical	Furnished By	Set in Place By	Power By	Control By
Manually controlled	EC	EC	EC	EC
Manually controlled, and that are furnished as part of factory wired equipment	MC	MC	EC	MC
Combination disconnect and motor starter	EC	EC	EC	CC
Motor Control Centers	EC	EC	EC	CC
Variable Speed Drives	MC	EC	EC	CC
Push-button stations, pilot lights, contactors, multi-speed switches	EC	EC	EC	EC
Disconnect switches, thermal overload switches, manual operating switches	EC	EC	EC	--
Multi-speed switches furnished as part of factory wired equipment	MC	MC	EC	MC
Temperature control relays, transformers, electric thermostats, time clocks, etc., that are not part of factory furnished equipment	CC	CC	CC	CC
Remote bulb thermostats, motor valves, controls, which are an integral part of factory furnished mechanical equipment.	MC	MC	EC	MC
Fire sprinkler suppression controls	MC	MC	EC	MC
Duct smoke detectors, including relays for fan shutdown	MC	MC	EC	EC
Fire/Smoke Dampers	MC	MC	EC	EC
Control Systems	CC	CC	CC	CC
Damper & Valve Actuators (120 v)	CC	CC	EC	CC
Damper & Valve Actuators (24 v)	CC	CC	CC	CC
Master Building Power quality monitors (loss/reversal)	EC	EC	EC	CC
Boiler and water heater controls, boiler burner control panels, internally wired	MC	MC	EC	MC
Electric Generator(s)				
Genset(s)	EC	EC	EC	EC
Fuel Lines	MC	MC	--	--
Day Tank (if separately furnished)	MC	MC	EC	MC
Silencer	EC	MC		

\* Provide starters in accordance with the Electrical Division of these Specifications. Note that a thermal overload relay in each phase is required for each starter (packaged equipment included).



2. Coordination with Room Numbering:
  - a. Certain systems provided under this Division rely on identification systems that are based on room names or numbers.
  - b. The numbering scheme indicated in this Project Manual is based on room numbers assigned during the design process.
  - c. The Contracting Agency reserves the right to change the numbers prior to Substantial Completion, and the final names and numbers will not necessarily match those found in the Project Manual.
  - d. Obtain from The Contracting Agency the final room numbers prior to commencing the numbering of Divisions 20, 21, 22, 23, 25 systems.
  - e. Tag and label system equipment and devices in accordance with the final numbering scheme at no additional cost.

### 3.3 REPAIR/RESTORATION

- A. Touch-up, repair or replace product components broken during installation or startup with new replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.
- C. Clean and repair existing identification tags/labels, hangers, supports, insulation, materials, instrumentation, and equipment that remain or are to be reused or are affected by this work. Materials and equipment which require major repair may be replaced at the Contractor's option.
- D. Plug, patch and repair surfaces, adjacent construction, and finishes damaged during demolition and new work. Restore to original condition or better including fire, smoke or temperature ratings or listings. Retexture surfaces to match surrounding surfaces. Repaint affected surfaces, with extent of paint to include adjacent surfaces to next wall or other clean break to avoid mismatched finish. Replace cracked or damaged ceiling tiles. Repair fire proofing, assembly fire ratings, and construction resistant to the passage of smoke.

### 3.4 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
  1. The Contracting Agency may inspect and approve sample installation of systems and equipment prior to general installation of units.
  2. Schedule, obtain, and pay for fees and/or services required by the local Authorities Having Jurisdiction and by these specifications, to test the mechanical systems.
  3. Notify the Contracting Agency a minimum of 24 hours in advance of tests. Certify in writing that specified tests have been made in accordance with the specifications.
  4. Immediately correct deficiencies that are discovered during the tests and repeat tests until system is approved. Do not cover or conceal piping, equipment or other portions of the mechanical installations until satisfactory tests are made and approved.

5. Under the direction of the Contractor and in the presence of the Contracting Agency, place the entire mechanical installation and/or any portion thereof in operation to demonstrate satisfactory operation.
6. Arrange for the Contracting Agency to witness tests. The Contracting Agency may waive witnessing any specific test at its discretion.

B. Non-Conforming Work:

1. Expediently remove and provide new for work not conforming to the Project Manual upon discovery; including warranty and discovery periods.
2. Warranty period shall start over for replaced equipment and installation from the date of accepted by the Contracting Agency.

C. Manufacturer Services:

1. Authorized manufacturer's representative shall be on-site for testing, start-up, functional check-out, and commissioning of equipment and systems.
2. Procurement, installation, start-up, and warranty services to be provided by manufacturer's authorized representative and service company.
3. Equipment, devices, hardware, and software to be approved for application, and of current production. Original manufacturer's parts, hardware, software, and support to be available for ten years after installation.

### 3.5 CLEANING

- A. Upon completion of installation and prior to initial operation, remove debris, and clean and wipe down equipment, piping, ductwork and floor to eliminate dust and dirt.

### 3.6 CLOSEOUT ACTIVITIES

- A. Demonstration: Provide demonstration, conducted by authorized factory start-up personnel, to the Contracting Agencies authorized personnel as listed in each individual specification section.
- B. Training: In addition to training specified in each individual specification section, provide 8 additional hours of operational instruction conducted by qualified personnel, covering any of the mechanical systems and installation requested by the Contracting Agency to its authorized maintenance personnel.

END OF SECTION 200000

## SECTION 200513 - COMMON MOTOR REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: This section describes general requirements, products and methods of execution relating to electric motors in general and shall apply to motors furnished as integral parts of equipment specified in this and other Divisions.
- B. Related Sections:
  - 1. 019100 - Commissioning
  - 2. 200000 - Mechanical General Requirements
  - 3. 232123 - Hydronic Pumps
  - 4. 233400 - HVAC Fans
  - 5. 235223 - Cast Iron Boilers and Accessories
  - 6. 236400 - Packaged Water Chillers
  - 7. 237323 - Central Air Handling Units
  - 8. 238123 - Dedicated Air-Conditioning Units
  - 9. 238200 - Terminal Heating and Cooling Units
  - 10. 254000 - Variable Speed Drives

#### 1.2 REFERENCES

- A. Codes and Standards: National Electrical Manufacturers Association, NEMA, Standards Publication Motors and Generators, MG-1.

#### 1.3 SYSTEM DESCRIPTION

- A. Performance Requirements: Provide product performance characteristics as specified or scheduled on drawings.

#### 1.4 PREINSTALLATION MEETINGS

- A. Coordinate installation of electrical motors with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

## 1.5 SUBMITTALS

- A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.
- B. Product Data:
  - 1. Provide a tabular listing of motors including the following information: Tag (from drawings), location, function, actual nameplate FLA, fuse size used, overload relay used, and overload setting.
  - 2. Make copy of list available during Substantial Completion observation by the Contracting Agency. Include list in Operations and Maintenance Manuals.

## 1.6 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Manufacturers: Company specializing in manufacturing the Products specified in this section with minimum 3 years' experience.
- B. Certifications: Motors shall conform to governing NEMA Standards and ASA Form C-50 for rotating machinery.

## 1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements:
  - 1. Verify motors are new and delivered in original product/factory packaging/crating and are free from damage and corrosion.
  - 2. Replace products delivered to job site that do not comply with above requirements at no expense to Owner.
- B. Storage and Handling Requirements:
  - 1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Replace damaged items with same item in new condition.

## 1.8 WARRANTY

- A. Manufacturer Warranty: See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 MOTORS IN ELECTRICAL CLASSIFIED LOCATIONS

- A. Motors used in environments indicated to be NEC Class I, Division I shall be built and labeled as explosion-proof for the Group and autoignition temperature, NEC T-code.
- B. Motors used in environments indicated to be NEC Class I, Division II:
  - 1. Listed for Class I Division I environments.
  - 2. Listed for Class I Division II environments.
  - 3. Does not have arc-producing brushes or switching mechanisms which could act as ignition sources.
  - 4. Motors that include a space heater, its surface temperature may not exceed 80% of the autoignition temperature of the hazard.

2.2 SUPPLY VOLTAGE

- A. Supply voltage shall be determined from the electrical plans where nominal utility voltage will be indicated.
- B. Motor voltage shall be stamped on the nameplate and relate to the nominal voltage as follows:

THREE PHASE MOTORS	
Nominal Volts	Motor Ratings
208 volts	200V, 208V, or 208/220V
240 volts	220V or 208/220V
480 volts	460V
SINGLE PHASE MOTORS	
Nominal Volts	Motor Ratings
120 volts	115V or 115/230V
240 volts	230V or 115/230V
208 volts	200V or 208V

Note: Provide nameplate indicating that voltage for a motor operating at 208 VAC is suitable.

- C. Provide two sets of windings for two speed motors. Furnish two-speed starter to suit motor for two-speed motors. Starter to be installed under Division 26.

- D. Voltage variation: Motors shall be designed to operate within the parameters of these requirements at rated load and with a voltage variation from the name plate voltage of plus or minus ten percent.
- E. Motors shall operate successfully at rated load and at rated voltage with a maximum frequency variation of five percent above or below rated frequency.
- F. Motors shall operate successfully at rated load with a combined maximum variation in the voltage and frequency of five percent above or below rated voltage and rated frequency.
- G. Motors that operate with Variable Speed Drive (VSD) controllers shall be suitable for the application.
  - 1. Motors operated using PWM type VSIDS: Conform to NEMA MG 1 Part 31 requirements.
  - 2. Motors operated using six-step type VSIDS: Conform to NEMA MG 1 Part 30 or Part 31 requirements.

### 2.3 LOCKED ROTOR CURRENT

- A. No motor above 15 HP shall have a locked rotor current in excess of NEMA code letter "G". Smaller motors may have a higher locked rotor rating, but in no case exceeding the recommended NEMA rating as related to motor size.

### 2.4 MOTOR INSULATION

- A. Unless otherwise specified, motor insulation shall be NEMA Class "B" (or better). Based on 40 degrees C maximum ambient, and 90 degrees C maximum rise, total maximum operating temperature shall not exceed 130 degrees C.

### 2.5 MOTOR LOADING

- A. No motors shall be subjected to loads exceeding the motor nameplate rating, under any normal operating condition.

### 2.6 MOTOR RATING

- A. Motors are sized in conformity with the manufacturer's published information and shall not be interpreted as the final requirement. Check each motor for adequacy in relation to the specific application.
- B. Motors indicated as being connected to variable speed drives (VSD) shall be rated for VSD service.

## 2.7 HIGH EFFICIENCY AC MOTORS

- A. Furnished high efficiency electric motors for equipment that:
  - 1. Require a three horsepower or larger drive motor.
  - 2. Have duty cycles classified as continuous.
- B. Efficiency of the motors shall be determined by NEMA Standard MG 1 - 12.536 and shall have efficiencies equal to or better than:

Motor Size	Nominal Efficiency
Through 3 HP	89 percent
Over 3 HP through 10 HP	91 percent
Over 10 HP through 30 HP	93 percent
Over 30 HP through 60 HP	94 percent
Over 60 HP through 100 HP	95 percent
Over 100 HP	95 percent

## 2.8 MOTOR HOUSING FEATURES

- A. Open drip-proof, totally enclosed fan cooled (TEFC), or explosion-proof, as appropriate for the use intended and the environment where installed, or as noted. Provide totally enclosed fan cooled motors for equipment below grade, located outdoors, or operating in damp or dust-laden locations. Provide a continuous moisture drain that is screened against insect entry for totally enclosed motors.
- B. Oversized external conduit boxes at least one size larger than NEMA standard.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection of In-Place Conditions: Cover motors to protect them from construction dirt and debris.

### 3.2 INSTALLATION

#### A. Special Techniques:

1. Installation of motors shall be as required by the driven equipment. Make sure motor design and characteristics are suitable for the application.
2. Electrical connections for motors shall conform to NEC Articles 430 and 440 as applicable, and to any state and local code having jurisdiction.
3. Unless furnished as part of a complete package including disconnects and control, and/or motor fuse protection, protect motors by Bussmann Fusetron Dual-Element Time Delay fuses, or approved equal.
4. Megger motor windings prior to starting. Include log of megger readings in the Operations and Maintenance manuals.
5. Verify correct rotation of motors.
6. Comply with Article 460 of the National Electrical Code for installation of power factor correction capacitors.
7. Motor sizes shown on the Drawings are estimates based upon the mechanical design. Where motors actually furnished are of a different size than those shown, motor circuit components (starters, disconnects, overcurrent devices, and conductors) shall be revised to suit the motors actually furnished, without increase in the Contract amount. Similarly, motor overcurrent device sizes shown on the Drawings or specified are based upon estimated motor code letters, overcurrent device manufacturers' recommendations, and full-load currents from the NEC Tables. Where the motors actually furnished require different sizing, the sizes of the overcurrent devices shall be adjusted to conform to the NEC, without increase in the Contract amount.

### 3.3 REPAIR/RESTORATION

- A. Repair any components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

END OF SECTION 200513



## SECTION 200529 - MECHANICAL HANGERS AND SUPPORTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. General hanger and support requirements for building service piping and mechanical equipment not required to be vibration and/or seismically controlled.
2. Penetrations, sleeves and seals.

##### B. Products Installed But Not Supplied Under this Section:

1. Vibration Isolation and Seismic Control anchoring and support systems furnished by Section 200548 - Mechanical Vibration and Seismic Control.

##### C. Related Sections:

1. 019100 - Commissioning
2. 033000 - Cast-in-Place Concrete
3. 075000 - Single-Ply EDPM Membrane Roofing
4. 099100 - Painting
5. 200000 - Mechanical General Requirements
6. 200513 - Common Motor Requirements
7. 200548 - Mechanical Vibration and Seismic Control
8. 200553 - Mechanical Identification
9. 200700 - Mechanical Insulation
10. 221100 - Domestic Water Piping and Specialties
11. 221300 - Sanitary Waste and Vent Piping and Specialties
12. 224000 - Plumbing Fixtures
13. 231113 - Fuel Oil Piping and Specialties
14. 232113 - Hydronic Piping and Specialties
15. 232123 - Hydronic Pumps

16. 233100 - Ducts and Accessories
17. 233400 - HVAC Fans
18. 233600 - Air Terminal Units
19. 233700 - Air Outlets and Inlets
20. 235100 - Breechings, Chimneys and Stacks
21. 235223 - Cast Iron Boilers and Accessories
22. 236400 - Packaged Water Chillers
23. 237323 - Central Air Handling Units
24. 238123 - Dedicated Air-Conditioning Units
25. 238200 - Terminal Heating and Cooling Units
26. 238316 - Radiant Floor Heating Equipment
27. 254000 - Variable Speed Drives

## 1.2 REFERENCES

### A. Codes and Standards:

1. International Building Code (IBC).
2. International Mechanical Code (IMC).
3. Uniform Plumbing Code (UPC).
4. MSS SP58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
5. SMACNA HVAC Duct Construction Standards - Metal and Flexible (current edition).

### B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.
2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.
3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

### 1.3 DESCRIPTION

#### A. Design Requirements:

1. Equipment and piping system support:
  - a. Select and apply pipe hangers and supports per MSS SP58 using stock or production parts whenever possible.
  - b. Design support spacing such that free span of piping does not exceed Code or MSS SP58 criteria (whichever is most restrictive).
  - c. Calculate required supporting force at each hanger location to confirm hanger type and hanger rod diameter selection.
  - d. Provide hangers such that equipment connection points do not carry connected piping load.
2. Vibration and seismic restraint systems: Coordinate the requirements of this section with Section 200548 - Mechanical Vibration and Seismic Control.

#### B. Performance Requirements:

1. Provide hangers and supports which allow for the free expansion and contraction of system piping without transferring tensile and compressive stresses to adjacent supports or connected equipment. Provide additional expansion loops, pipe anchor and pipe guide assemblies as required.
2. Coordinate hanger and support anchor locations and embedment depth requirements with structural.
3. Support fire suppression system piping and equipment accordance with the provisions of Section 211000 - Water Based Fire Suppression Systems.
4. Support plumbing piping in accordance with this section and Uniform Plumbing Code requirements; whichever is more restrictive. In case of conflicts, follow UPC guidance.
5. Support ductwork in accordance with Section 233100 - Ducts and Accessories.
6. Special Performance Requirements for Open Ceiling Spaces:
  - a. Coordinate the support of piping, ductwork, lighting and electrical cabling in open ceiling spaces (utilizing the shop drawing review process) to provide a uniform and symmetrical appearance.
  - b. In general, utilize trapeze hanger style support systems with hangers equally spaced based on the limiting component being supported. Provide hanger rods vertical and straight. Trim hanger rod ends to provide a "finished" appearance.

### 1.4 PRE-INSTALLATION MEETINGS

- A. Coordinate installation of equipment and associated piping or ductwork with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

## 1.5 SUBMITTALS

- A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.
- B. Product Data:
  - 1. Provide manufacturers catalog data, including load capacity, embedment depth.
  - 2. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.
- C. Shop Drawings:
  - 1. Provide shop drawings for housekeeping pads (with dimensioned penetrations) and field fabricated support systems.
  - 2. Provide shop drawings to show system layout with location and detail of hangers, anchors, dimensioned expansion loops and guides. Coordinated with Section 200548 - Mechanical Vibration and Seismic Control shop drawing submittal.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance (IO&M) Manuals:
  - 1. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
  - 2. Include the following:
    - a. Copies of approved submittal information.
    - b. Manufacturer's installation, operating and maintenance/repair instructions, parts listings, and spare parts list for each product. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
- B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.
- C. Record Documentation:
  - 1. Indicate installed locations of hangers, supports and expansion control assemblies on record drawings on associated piping record drawings.
  - 2. Provide Operating and Maintenance Data (installation and adjustment instructions) for non-commodity products.

## 1.7 QUALITY ASSURANCE

### A. Qualifications:

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years documented experience.
2. Installers: Minimum 3 years' experience.
3. Testing Agencies: Provide piping and support systems designed and manufactured per MSS SP58.
4. Licensed Professionals: Provide piping and support systems designed per MSS SP58.

## 1.8 DELIVERY, STORAGE, AND HANDLING

### A. Acceptance at Site:

1. Verify products are delivered in original factory packaging and are free from damage and corrosion.
2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Owner.

### B. Storage and Protection:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.
2. Handle items to avoid damage.
3. Replace damaged items with same item in new condition.

## 1.9 WARRANTY

### A. Manufacturer Warranty:

1. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.
2. Provide 1 year manufacturer's warranty.
3. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.
4. Provide to the Contracting Agency 1 copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

## PART 2 - PRODUCTS

### 2.1 PIPE HANGERS AND SUPPORTS

#### A. General:

1. Piping and support systems shall be malleable iron, steel or copper.
2. Ferrous hangers and supports installed outdoors or in unheated spaces shall be hot dipped galvanized.
3. Select and apply pipe hangers and supports per MSS SP58.
  - a. Use stock or production parts whenever possible.
  - b. Calculate weight balance to determine the required supporting force at each hanger location and to eliminate pipe weight load at each equipment connection.
4. Fabricate and install pipe hangers and supports per MSS SP58 recommended practices.
5. Hangers shall be designed to securely lock using a mechanical fastener. Hangers and supports using gravity type locking are not acceptable. For example, adjustable swivel ring Type 6 is not allowed.
6. Pre-engineered support systems such as Unistrut, Super-Strut, B-Line and K-Line may be used in accordance with manufacturers load limits.
7. Manufacturers: Grinnell, M-CO Michigan Hanger Company, Kin Line.

#### B. Plumbing Piping:

1. Conform to the Uniform Plumbing Code requirements.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Adjustable swivel ring; split ring.
3. Hangers for DWV and Cold Pipe Sizes two inch and over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe sizes two to four inch: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes six inches and over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers under six inches: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes six inches and over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Supports: Welded steel bracket and wrought steel clamp.
9. Wall Support for Hot Pipe Sizes six inches and over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

10. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
11. Floor Support for Hot Pipe Sizes up to four inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
12. Floor Support for Hot Pipe Sizes six inches and over: Adjustable cast iron roll and stand, steel screws, and steel support.
13. Vertical Support: Steel riser clamp.
14. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Hydronic Piping:

1. Conform to ASME B31.9 and the International Mechanical Code.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Adjustable swivel ring; split ring.
3. Hangers for Cold Pipe Sizes two inches and over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe sizes two to four inch: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe sizes six inches and over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes six inches and over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support: Welded steel bracket and wrought steel clamp.
9. Wall Support for Hot Pipe Sizes six inches and over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
12. Floor Support for Hot Pipe Sizes up to four inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
13. Floor Support for Hot Pipe Sizes six inches and over: Adjustable cast iron roll and stand, steel screws, and steel support.
14. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Refrigerant Piping:

1. Conform to ASME B31.5.
2. Hangers for pipe sizes 1/2 to 1-1/2 inch: Adjustable swivel ring, split ring.
3. Hangers for pipe sizes two inches and over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support: Welded steel bracket and wrought steel clamp.
6. Vertical Support: Steel riser clamp.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
8. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

## 2.2 ACCESSORIES

- A. Hanger Rods: Mild steel, threaded both ends, threaded one end, or continuous threaded.
- B. Escutcheons: Nickel or chrome plate with screws or springs for holding plate in position.
- C. Pipe Protection Saddles: Shop fabricate or purchase specially manufactured saddles specifically designed for the intended use. Provide saddles where roller type support is used, or where the pipe hanger is installed outside the insulation for protection of insulating jacket.
- D. Outdoor applications: Metal components shall be galvanized.

## 2.3 INSERTS

- A. Provide inserts to match the load bearing capacity of hangers scheduled in Part 3.
- B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over four inches.
- C. Concrete deck inserts: Galvanized rod, steel plate, similar to Kin-Line figure 293.
- D. Screw insert for concrete: Malleable iron similar to Grinnell figure 152.

## 2.4 PRE-ENGINEERED SUPPORT SYSTEMS

- A. Manufacturers:
  1. Unistrut.
  2. Super-Strut.
  3. B-Line.



4. K-Line.
  5. Erico.
- B. Materials:
1. Cold worked steel.
  2. Type 304 stainless steel: Use for PVC, liquid-tight flex, or plastic-coated conduit installed to wood construction in outdoor, damp, corrosive or marine environments.
- C. Finish:
1. Heated indoor areas: Pre-galvanized zinc coating.
  2. Outdoor areas: Hot dipped galvanized finish. In addition, coat hot dipped galvanized finish channel field cuts with zinc rich paint provide by the support system manufacturer.
  3. Painted areas: Paintable galvanizing or phosphatized and primed.
  4. Surface metal raceways: U.L. Listed epoxy coating.
- D. Channel:
1. Standard Size: 1-5/8 inch x 1-5/8 inch. Gauge thickness as required for attached load.
  2. Standard Hole Pattern: Slotted. Provide solid channel in exposed public areas.
- E. Nuts and Hardware:
1. Channel nuts: Hardened steel (ASTM-A675 and ASTM A36).
  2. Bolts, screws and nuts: Hardened steel (ASTM-A307, ASTM A563 and SAE J429).
  3. Finish: Electroplated zinc.
- F. Fittings: Plate steel (ASTM A635). Epoxy or electroplated zinc coating.
- G. Mechanical Accessories: Provide accessories from the support system manufacturer designed for the specific equipment to be supported to include but not limited to:
1. Splice and gusset plates.
  2. Corner angles.
  3. Specialized support brackets.
  4. Beam clamps with restraints.
  5. Column supports.
  6. Strut pipe clamps.

7. Straps.
8. Brackets.

## 2.5 SLEEVES, ACOUSTICAL SEALS AND FIRE-STOPPING

- A. See Part 3 - PENETRATIONS.
- B. Sleeves for pipes through fire rated and fire resistive floors and walls, and fire proofing: UL listed prefabricated fire rated sleeves and seals.

## 2.6 WALL/FLOOR PENETRATION WATER SEALS

- A. Mechanical seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
- B. EPDM seals.
- C. 316 Stainless steel bolts and nuts.
- D. Hot-dipped galvanized or coated sleeve with full water stop flange with continuous weld on both sides.
- E. Manufacturer: Metraflex, Thunderline, Crouse-Hinds, or approved equal.

## PART 3 - EXECUTION

### 3.1 INSTALLERS

- A. Installer: Perform work by experienced personnel previously engaged in construction and under the supervision of a qualified installation supervisor.

### 3.2 PREPARATION

- A. Prior to installation, prepare detailed shop drawings of the planned installation of hanger and support products specified by this section. Coordinate the location, type and size of hangers and supports, housekeeping pads (thickness/perimeter overhang dimensions) and roof curbs with Architectural and Structural elements utilizing the shop drawing review process.
- B. Submit shop drawings required by this section coordinated with the seismic design and associated shop drawings required by Section 200548 - Mechanical Vibration and Seismic Control as a single submittal.
- C. Do not install hangers and supports without approved shop drawings.

### 3.3 INSTALLATION

#### A. Special Techniques:

1. Install vibration isolators, seismic control and wind restraint systems in compliance with the manufacturer's written instructions and certified and approved application engineering installation drawings and details in accordance with Section 200548 - Mechanical Vibration and Seismic Control.
2. Insert and Attachment Installation:
  - a. Inserts:
    - 1). Provide inserts or cast-in-place channels for placement in concrete formwork.
    - 2). Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
    - 3). Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
    - 4). Use expansion type anchor bolts with pre-cast concrete including concrete masonry units within loading limits of the pre-cast material and anchor bolt manufacturer's recommendations.
    - 5). Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
    - 6). Plastic screw inserts and caulked lead inserts are prohibited, except for mounting instructions and control diagrams.
  - b. Attach mechanical equipment to structure as follows:
    - 1). Hollow masonry: Toggle bolts.
    - 2). Solid masonry and concrete: Preset inserts or expansion bolts.
    - 3). Structural steel: Beam clamps which engage both sides of structural member or have retaining clips or other approved means for positive engagement.
    - 4). Metal surfaces: Machine screws, bolts or welding.
    - 5). Wood construction: Wood or sheet metal screws.
    - 6). Do not use powder-actuated fasteners for anchorage in tension applications. Obtain written permission from the Owner prior to using any type of powder powered studs.
3. Pipe Hanger and Support Installation:
  - a. Install hangers and supports in accordance with manufacturer's instructions, applicable Code requirements and approved shop drawings.
  - b. Support horizontal piping as scheduled.
  - c. Independently support piping at equipment, so that the equipment supports no weight.
  - d. Insulated piping shall have insulation saddles or 18 gauge steel insulation shields combined with sections of calcium silicate or cellular glass. Cold piping shall always be supported over the insulation and vapor barrier. Subject to approval, hot piping may be insulated around the supports.
  - e. Trapeze hangers shall be used when more than three pipes run parallel and at same elevation. Provide rollers for hot pipes. Design rods and cross members to support three times the weight of pipes and contents plus 250 pounds.

- f. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
  - g. Place hangers within 12 inches of each horizontal elbow.
  - h. Use hangers with 1-1/2 inches minimum vertical adjustment.
  - i. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between hangers.
  - j. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
  - k. Support riser piping independently of connected horizontal piping.
  - l. Provide saddles where roller type support is used, or where the pipe hanger is installed outside insulation for protection of insulating jacket.
  - m. Piping requiring Vibration Isolation:
    - 1). Coordinate with Section 200548 - Mechanical Vibration and Seismic Control for piping requiring vibration isolation.
    - 2). Support main risers less than 20 feet in height only at mid-level, with riser guides at other levels.
    - 3). Do not support vibration isolated piping along with non-isolated piping on a common trapeze.
    - 4). Rigidly mount steel spring hanger boxes to the supporting structure. Do not locate in the middle of the hanger rod.
    - 5). Rigid pipe anchors are not permitted in vibration isolated piping circuits. When pipe anchors are required.
4. Equipment Bases and Support Installation:
- a. For cast-in-place concrete requirements refer to Division 3 - Concrete.
  - b. Provide 5-1/2 inch (2x6 form) concrete housekeeping pads for floor mounted central air handling units. Coordinate perimeter overhang dimensional requirements (12 inches typical) with Section 200548 - Mechanical Vibration and Seismic Control, such that air handler anchor bolts achieve proper embedment.
  - c. Provide 3-1/2 inch (2x4 form) concrete housekeeping pads for all other floor mounted mechanical equipment. Coordinate perimeter overhang dimensional requirements (8 inches typical) with Section 200548 - Mechanical Vibration and Seismic Control, such that equipment anchor bolts achieve proper embedment.
  - d. Construct field fabricated equipment bases and supports from steel members and/or pre-engineered support systems. Prime and paint bases and supports black in accordance with Division 9 - Finishes. Pre-engineered support systems which are factory coated are not required to be painted.
5. Mechanical Equipment Installation:
- a. Provide hardware and accessories necessary to mount fixtures and equipment. Adapt to field conditions.
  - b. Securely fasten fixtures and equipment to the building structure in accordance with the manufacturer's installation recommendations.
  - c. Provide fabricated steel support frames and bases for equipment not directly mounted on floor. For belt driven equipment provide rigid structural base in common with motor to maintain belt tension.
  - d. Provide steel base plates for floor mounted fixtures and equipment to distribute the weight such that the floor load is not more than 100 PSF, unless special structural reinforcement is submitted for approval.

- e. At wall attached fixtures and equipment weighing less than 50 pounds, provide backing plates at least 1/8 by 10 inch square sheet steel or two by 10 inch fire retardant treated wood securely built into the structural walls. Submit attachment details of heavier equipment for approval.
  - f. Painted fabricated steel support black in accordance with Division 9 - Finishes.
6. Penetrations:
- a. Coordinate mechanical penetrations with architectural and structural construction details prior to installation. Set sleeves in position in concrete formwork. Provide reinforcement around sleeves as required.
  - b. Provide compatible materials, fasteners, adhesives, sealants, and other products required for proper installation.
  - c. Provide penetrations through roof, exterior walls and floors (See floor penetration seals) to be weather and water tight.
  - d. Fire-Stopping: Provide UL rated fire-stopping assemblies for rated roof, wall and floor penetrations in accordance with Division 7.
  - e. Pipe and Duct Sleeves/Framed Openings:
    - 1). Provide sleeves for pipe and round ducts less than 16 inches diameter passing through floors, walls, ceilings, or roofs. Fabricate sleeves in non-load bearing walls from 20 gauge galvanized sheet steel conforming to ASTM A924 / A924M. Fabricate sleeves in load-bearing walls from standard-weight galvanized steel pipe conforming to ASTM A53 / A53M. Provide 1 inch clearance between the pipe or duct and sleeve opening. Oversize sleeves for cold piping to allow continuous insulation through sleeve.
    - 2). Provide framed openings for round ducts 16 inch diameter and greater and rectangular ductwork passing through floors, walls, ceilings, or roofs. Provide structural steel members for framed openings conforming to ASTM A36 / A36M. Provide 1 inch clearance between the duct and framed opening.
    - 3). Provide closure collars not less than 4 inches wide on each side of duct wall or floor penetration where sleeves or framed openings are provided. Fabricate collars for round and rectangular ducts with a minimum dimension less than 16 inches from 20 gauge galvanized steel. Fabricate collars for round and rectangular ducts with a minimum dimension of 16 inches or greater from 18 gauge galvanized steel.
    - 4). Provide escutcheons for piping and conduit passing through walls, floors and ceilings in finished areas, below counters and inside closets and casework subject to view when doors are open. Size escutcheons to cover sleeves. Secure escutcheons in position.
  - f. Acoustical Seals:
    - 1). Monolithic sound walls (i.e. poured concrete or masonry): Provide wall sleeve with approximately one-inch annular space around pipe. Pack annular space with backer rod or acoustical filler as specified in Division 7. Allow a 1 inch recess at each end of sleeve. Caulk sleeve flush with flexible sealant or firestopping material as specified in Division 7.
    - 2). Where acoustical wall is a two component type, such as a staggered or double stud partition, treat each component as a separate wall. Pack and seal each half of penetration sleeve as previously specified, except that only the exposed end of each sleeve portion can be caulked with sealant or fire-stop. Provide adequate separation between each sleeve.

- g. Floor Penetration Seals:
  - 1). Provide pre-engineered floor penetration water seal systems for floor penetrations in rooms where a pipe leak/failure could result in water damage to adjacent spaces (i.e. mechanical rooms located above the ground floor or basement) and other areas as noted.
  - 2). Floor penetrations to include but not limited to: Building service piping, conduit, ductwork and building automation system wiring.
  - 3). Extend floor penetration sleeves 2 inches above finished floor.
- 7. Roof Flashing: Provide EDPM pipe penetration and roof curb flashing in accordance with Section 075000 - Single-Ply EDPM Membrane Roofing, as an integral part of the roofing system.
- B. Interface with Other Work: Coordinate and sequence installation of hangers and supports with trades responsible for portions of this and other related sections of the Project Manual.

3.4 REPAIR/RESTORATION

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

3.5 SITE QUALITY CONTROL

- A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

3.6 CLEANING

- A. Waste Management: After construction is completed, clean and wipe down exposed surfaces.

3.7 TABLE

- A. Pipe Support: Provide pipe support spacing as indicated in the table below except where spacing more restrictive by Code.

PIPE SIZE (Inches)	HANGER SPACING MAX (Feet )		
	Steel		Copper
	Water Filled	Gas Filled	Polyethylene (1)
1/2	7	9	5
3/4	7	9	5

PIPE SIZE (Inches)	HANGER SPACING MAX (Feet )			
	Steel		Copper	Polyethylene (1)
	Water Filled	Gas Filled		
1	7	9	6	
1-1/4	7	9	7	
1-1/2	9	12	8	4
2	10	13	8	4-1/2
2-1/2	11	14	9	
3	12	15	10	5
4	14	17	12	6
6	17	21	14	
8	19	24	16	

(Based on Table 4, MSS SP-58, except for PE piping)

(1) (Based on manufacturer's data)

END OF SECTION 200529

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## SECTION 200548 - MECHANICAL VIBRATION AND SEISMIC CONTROL

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. This section specifies performance requirements for the design, furnishing, installation, supervision, and administration for all aspects of thermal expansion and contraction, vibration isolation, and seismic control of non-structural mechanical elements of the Project as shown on the drawings and/or specified in this and other Divisions for this nonessential facility. This is substantially a "performance" specification, unless otherwise noted.
2. It is the design intent to seismically anchor, brace, and support the facility's non-structural mechanical and electrical elements, including pre-engineered equipment, to the building's structure. This includes mechanical and electrical equipment, system piping and electrical raceways, tanks, vessels, flues, equipment racks, and cabinets, and equipment and assemblies that may be specified in other Divisions.
3. Seismic submittals, permits, and inspections required by the Authority Having Jurisdiction (AHJ) and this section shall be included.

##### B. Design Requirements:

1. Obtain the services of a specialized and qualified single source manufacturing and design firm (Seismic Design Firm) to design the overall vibration and seismic control restraint systems, including related thermal expansion and contraction control and wind effects, for the non-structural elements of this Project in accordance with the International Building Code (IBC) chapters 16 and 17.
2. Duties of the Seismic Design Firm include:
  - a. Specialized design, product review, and product selection.
  - b. Site verification and written certification that the installed vibration and seismic control and related products and systems meet the specialized design requirements.
3. Exceptions:
  - a. Pre-engineered seismically designed and certified assemblies in accordance with IBC, accompanied with written "Certificate of Compliance" acceptable to the Authority Having Jurisdiction, AHJ.
  - b. Pre-manufactured equipment designed in accordance with IBC accompanied with written "Certificate of Compliance" acceptable to the Authority Having Jurisdiction.

##### C. Related Divisions and Sections:

1. 019100 - Commissioning
2. Divisions 20, 21, 22, 23, 25 - Mechanical
3. Divisions 26, 27 and 28 - Electrical

## 1.2 RELATED WORK

- A. Roof and wall structure supporting mounted equipment and hoods shall be designed for seismic and wind forces including, but not limited to tension, compression, and moment loads. The design shall comply with IBC requirements including load path to structure.
- B. See Section 033000 - Cast-In-Place Concrete for housekeeping pad material and construction/attachment methods. Actual housekeeping pad locations, dimensions and through penetrations shall be coordinated with approved equipment base dimensions, weights, and anchoring requirements utilizing the product submittal and shop drawing process.
- C. Coordinate with mechanical and electrical hanger and support specifications Section 200529 - Hangers and Supports, Section 233100 - Duct Accessories, and Section 260529 - Hangers and Supports for Electrical Systems, for related items of work and requirements.
- D. Equipment, tanks, and related items attachment and concrete housekeeping pad embedment requirements shall be designed by the Seismic Design Firm in accordance with this section.
  1. Housekeeping pads are typically sized for a minimum of 8-inch clearance all around the equipment or 12 times the anchor bolt diameter, whichever is greater.
  2. Where exterior isolators are used, this distance is measured from the outermost holes in the isolator base plate to the edge of the housekeeping pad.

## 1.3 REFERENCES

- A. Perform work in accordance with the legally enacted editions and amendments of the following codes and standards:
  1. International Fire Code - 2012, IFC.
  2. International Mechanical Code - 2012, IMC.
  3. International Building Code - 2012, IBC.
  4. Uniform Plumbing Code - 2015, UPC.
  5. ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.
  6. NFPA 13 - 2010, Installation of Sprinkler Systems.
  7. NFPA 14 - 2010, Standpipes.
  8. NFPA 70 - 2014, National Electric Code, NEC.

9. NFPA 101 - 2012, Life Safety Code
- B. Provide materials, equipment, and installation methods which comply with the current standards of the following trade organizations:
  1. American National Standards Institute - ANSI.
  2. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE.
  3. American Society of Mechanical Engineers - ASME.
  4. American Society for Testing and Materials - ASTM.
  5. Federal Emergency Management Agency - FEMA.
    - a. Installation of Seismic Restraints for Mechanical Equipment FEMA 412.
    - b. Installation of Seismic Restraints for Electrical Equipment FEMA 413.
    - c. Installation of Seismic Restraints for Duct and Pipe FEMA 414.
  6. Institute of Electrical and Electronics Engineers - IEEE.
  7. Insulated Cable Engineers Association - ICEA.
  8. National Fire Code, National Fire Protection Association - NFPA.
  9. National Electrical Manufacturers' Association - NEMA.
  10. Underwriters Laboratories - UL.
  11. VISCMA - Vibration Isolation and Seismic Controls Manufacturers Association.

#### 1.4 DEFINITIONS

- A. Essential Facilities: Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow, or earthquakes.
- B. Life Safety and High Hazard:
  1. Fire suppression systems, smoke control systems, fire alarm systems, and related actuated dampers, fans, and control panels.
  2. Mechanical and electrical systems connected to and including emergency power generation equipment, transfer switches, transformers, and system components.
  3. Any closed system containing toxic, corrosive, refrigerant, flammable, oxidizing, oxygen reduction, combustibles, flue gases, gas or liquid which poses a health hazard if released into the environment; High Hazard.
  4. Medical and life support systems including medical gas equipment and piping.
  5. Compressed Gases:

- a. Any fixed tanks or piping containing hazardous, flammable, combustible, toxic, or corrosive materials, which include fuel gas, fuel oil, and gasoline.
- b. Flammable, oxidizing, oxygen depletion, and/or combustible gases and fluids which shall be contained within a closed system (i.e. any gases which pose a health hazard if released into the environment, High Hazard).
- c. Compressed gas piping.

C. General:

1. Anchor: A device, such as an expansion bolt, for connecting equipment bracing members to the structure of a building.
2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing analytical or inspection services, when such agency has been approved.
3. Attachment: See Positive Attachment below.
4. Basic Wind Speed: The basic wind speed (MPH) for determination of the wind loads shall be as per IBC or local code, if more severe. Local jurisdictions shall determine wind speeds for indicated special wind regions located near gorges or mountainous terrain.
5. Bracing: Metal channels, cables, or hanger angles that prevent components from breaking away from the structure during an earthquake or high winds. See also Longitudinal Bracing and Transverse Bracing. Together, they resist environmental loads from any direction.
6. Certificate of Compliance: A certificate stating that materials and products meet specified standards or that work was done in compliance with approved construction documents, provided by an approved agency.
7. Component: A non-structural part or element of an architectural, electrical, mechanical, plumbing, or fire suppression system within or without of a building system.
8. Component (Flexible): Component, including its attachments, having a fundamental period greater than 0.06 seconds.
9. Component (Rigid): Component, including its attachments, having a fundamental period less than or equal to 0.06 seconds.
10. Dynamic properties of piping: The tendency of pipe to change in weight and size because of the movement and temperature of fluids in them. This does not refer to movement due to seismic forces.
11. Equipment: Systems associated with ducts, pipes, and conduits also called components.
12. Failure: The discontinuance of any attachment point or load path between component and structure. Permanent deformation is acceptable as long as the component continues to operate without failure and if permanent, it is within acceptable manufacturing or structural tolerances.
13. Gas pipes: For the purposes of this specification, gas pipe is any pipe that carries fuel, gas, fuel oil, medical gas, compressed air, or refrigerants.

14. Hazardous Contents: A material that is highly toxic, potentially explosive, or corrosive and in sufficient quantity to pose a significant life-safety threat to the general public if an uncontrolled release were to occur.
15. High Hazard System: Any system handling flammable, combustible, or toxic material or other hazardous contents.
16. Inspection Certificate: An identification applied on a product by an approved agency containing the name of the manufacturer, the function and performance characteristics, and the name and identification of an approved agency that indicates that the product or material has been inspected and evaluated by an approved agency.
17. Ip, Component Importance Factor: A factor (typically 1.0 or 1.5) for calculating seismic forces on non-structural supports.
18. Label: Identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics, and the name and identification of an approved agency that indicates that the representative sample of the product or material has been tested and evaluated by an approved agency.
19. Lateral forces: Force acting on a component in the horizontal plane. This force can be in any direction.
20. Life Safety Components: Components required for the continued operation of the facility and whose failure could impair the facility's continued operation regardless of the governing Code.
21. Longitudinal bracing: Bracing that prevents a component from moving in the direction of its run.
22. Longitudinal force: An applied force that happens to be in the same direction as the duct or pipe run.
23. Mark: Identification applied on a product by the manufacturer indicating the name of the manufacturer and the function of a product or material.
24. Manufacturer's Designation: Identification applied on a product by the manufacturer indicating that a product or material complies with a specified standard or set of rules.
25. NRCA: National Roofing Contractors Association.
26. Occupancy Category: A classification used to determine structural load requirements including those imposed by wind, flood, snow, and seismic based on occupancy of the structure.
27. Positive Attachment: A mechanical device, designed to resist seismic forces, which connects a non-structural element, such as a duct, to a structural element, such as a beam. Bolts and welding are examples of positive attachments. Surface glue and friction anchorage do not constitute positive attachment. Examples of positive attachment are epoxy cast in anchors and drill in wedge shaped anchor bolts to concrete and welded or bolted connections directly to the building structure. Double-sided beam clamps, C type

are not acceptable as either brace point attachments to the structure or for the support of the component at the bracing location.

28. Periodic Special Inspection (PSI): See Special Inspection (Periodic).
29. Seismic: Related to an earthquake. Seismic loads on a structure are caused by wave movements in the earth during an earthquake.
30. Seismic Design Category: A classification assigned to a structure based on its Seismic Use Group or Occupancy Category and the severity of the design earthquake ground motion at the site.
31. Seismic Forces: The assumed forces prescribed herein, related to the response of the structure to earthquake motions, to be used in the design of the structure and its components.
32. Site Class: A classification assigned to a site based on the types of soils present and their engineering properties as defined in IBC.
33. Special Inspection (SI): Inspection as herein required of the materials, installation, fabrication, erection, or placement of components and connections requiring special documents and referenced standards.
34. Special Inspection (Continuous): The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.
35. Special Inspection (Periodic) (PSI): The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.
36. Story Drift Ratio: The story drift (Lateral displacement) divided by the story height.
37. Transverse Bracing: Bracing that prevents a component from moving from side to side.

## 1.5 SYSTEM DESCRIPTION AND CRITERIA

### A. Design Requirements:

1. Provide vibration isolation, seismic control, anchoring, system products, and application design and installation supervision services from a single pre-approved product manufacturer and a Seismic Design Firm.
2. Provide design to anchor, brace, and support the facility's non-structural elements, including pre-engineered equipment, to the building's structure. Provide all secondary structural elements to support, anchor, and transfer loads to the building structure. This includes mechanical and electrical equipment, tanks and vessels, system piping, and electrical raceways.

### B. Building Design Criteria:

1. Wind design data: See Structural Drawing.
2. Seismic design data: See Structural Drawing.
3. Component Importance Factors,  $I_p$ :
  - a. Life Safety Components, including fire suppression systems:  $I_p = 1.5$
  - b. Components containing High Hazardous materials:  $I_p = 1.5$
  - c. Mechanical and Electrical Equipment and Systems:  $I_p = 1.0$
  - d. All other components:  $I_p = 1.0$

C. Performance Requirements:

1. Design seismic restraint devices to accept the detailed forces acting through the equipment's center of gravity for the non-structural components of the project; this includes pad mounted and equipment exterior to the building envelope.
2. Responsibilities of the Seismic Design Firm include:
  - a. Professional structural engineering calculations, drawings, and details to show the restraint of non-isolated equipment.
  - b. Determination of vibration isolation and restraint product sizes and locations.
  - c. Supply and delivery of vibration isolation and seismic restraint products.
  - d. Provision of installation instructions, detailed shop drawings, and trained field supervision to insure proper installation and performance for work under this Section.
  - e. Review and approval or rejection of Certificates of Compliance from Original Equipment Manufacturers (OEM) furnishing seismically designed pre-engineered equipment or assemblies.
  - f. Certification of the correctness of installation upon completion.
3. Equipment with factory mounted internal vibration and seismic restraint devices shall meet the vibration and seismic control requirements of this section. In addition, the approved seismic design engineer shall review and approve the equipment's factory mounted internal vibration and seismic restraint devices and submit a written approval letter accompanying the equipment's initial product submittal for approval by the Contracting Agency.
4. In the event that the equipment is internally isolated and restrained, the entire unit assembly shall be seismically attached to structure.
5. Seismic and wind attachment between the equipment and the curb, rail, post, or concrete pad.

## 1.6 VIBRATION AND SEISMIC CONTROL DESIGN

### A. Seismic and Wind Load Certification and Analysis:

1. Prepare and submit professional structural engineering sealed calculations, drawings, and details substantiating the mounting system, seismic and/or wind restraints, and recommended anchor bolts for each piece of mechanical and electrical equipment will accept anchorage, through the component's load path to structure at its center of gravity, at the designated anchorage locations. Details and calculations shall include attachment to building structure or exterior pad. Show evidence of coordination with the structural engineer of record.
2. Calculations and supporting documents to clearly show assumptions, materials, dimensions, abbreviations, code references and formulas, force diagrams, and results intermediate steps to validate conclusions without the use of a computer program by the reviewer.
3. Design seismic loads.
4. Design wind loads.
5. Engineering calculations, drawings, and details, and product information shall be submitted to and approved by the Authority Having Jurisdiction and the structural Engineer of Record.

### B. Design Seismic Loads:

1. Calculate loads for both internal or external isolation and/or anchorage of components for the actual project location. Calculations to include minimum design loads and minimum horizontal and vertical restraint capability.
2. Analysis for anchorage to include:
  - a. Calculated dead loads.
  - b. Static seismic loads.
  - c. Material strength of anchoring material (system).
  - d. Load transfer to adequate structural members.
  - e. Detail of anchoring methods including:
    - 1). Bolt diameter.
    - 2). Embedment and/or welded depth, length, and type.

### C. Design Wind Loads:

1. Positively fasten outdoor mounted components to their supporting structure(s) to prevent failure due to wind load.
2. If equipment is mounted to a pre-engineered or field fabricated support bracket, provide positive attachment through welding or bolting of equipment to the support system.
  - a. Base loads and calculations on IBC and related ASCE sections.
  - b. Base equivalent IBC basic wind speed.



- c. Do not de-rate calculated wind load on outdoor equipment due to adjacent buildings, structures or screens.

## 1.7 SUBMITTALS

- A. Submittals shall be complete for review. Section submittal log to be the first section submitted along with Seismic Design Letter of Intent and related contractor's responsibility and section forms. Drawings, calculations, and products shall be complete and submitted together in one package. See Section 200000 - General Mechanical Requirements for additional requirements not covered below.
- B. Provide one hard copy of submittal for engineer's use. Provide an electronic copy of each submittal in PDF format with bookmarks matching table of contents, including shop drawings with each required paper, hard copy, submittal. Electronic Submittals shall generally follow the organization and formatting required for paper submittals. Provide electronic bookmarks within PDF file in place of tabs and sub-tabs. If individual PDF files are provided for each product or shop drawing sheet, organize files into folders and name files and folders to correspond with applicable specification sections or drawing titles.
- C. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Contract Documents.
- D. Product Data:
  1. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
  2. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  3. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and restraints by referencing numbered descriptive drawings.
  4. California Office of Statewide Health Planning and Development, OSHPD, bracing systems having a current anchorage preapproval "OPA" number shall be submitted with information on usage and capability to resist seismic forces noted as applicable when used for this project.
- E. For Seismic Design Categories C thru F:
  1. For Life Safety Components: Submit approved agencies Analytical or Shaker Test "Certificate of Compliance" certification. Analytical or Shaker Test through the component's load path including structure at its center of gravity shall include anchorage, structural and online capability.\*
  2. Components Needed for the Continued Operation of the Facility: Submit approved agencies Analytical or Shaker Test "Certificate of Compliance" certification. Analytical or Shaker Test through the component's load path including structure at its center of gravity shall include online capability.\*
  3. Components Containing Hazardous or Flammable Materials: Submit approved agencies Analytical or Shaker Test "Certificate of Compliance" certification. Analytical or Shaker

Test through the component's load path including structure at its center of gravity shall include anchorage, structural, online capability and hazardous material containment.\* Testing shall prove that no internal component will rupture to insure against loss of hazardous or flammable (explosive) material which could support combustion, ignite or contaminate.

4. \* Use of historical data is permitted if evidence confirms historical based component having the same construction and weight with accompanying center of gravity as the submitted unit and basis of historical claim conforms to loads derived in testing with accompanying accelerations based on AC-156, "Acceptance Criteria for Seismic Certification by Shake-table Testing of Nonstructural Components".
5. Components not listed and requiring only anchorage and load transfer compliance. Seismic design engineer shall submit professional engineer sealed engineering calculations, drawings, and details to support the project specific equipment will accept anchorage through the component's load path to structure at its center of gravity, at the designated anchorage locations.

F. Engineering Calculations:

1. Submit by a qualified Alaskan structural engineer sealed engineering calculations, drawings, and details to support the product selection and installation configuration for each vibration and seismic control restraint application.
2. Show evidence of coordination with the structural Engineer of Record.
3. Coordination and approval of non-structural element attachment techniques and design loads with the project's structural design Engineer of Record.

G. Substitutions:

1. Equipment manufacturers' substitution of internally or externally isolated and/or restrained equipment supplied by the equipment vendor, in lieu of the isolation and restraints is acceptable provided design conditions of this Section are met.
2. The equipment manufacturer shall provide a letter of guarantee from their Engineering Department, with professional engineer stamped and certified stating that the seismic restraints are in full compliance with these specifications. Letters from field offices or representatives are unacceptable.
3. Where used on an Essential or High Hazard Facility manufacturer's certification proving on line capability shall also be required. Letters from field offices or representatives are unacceptable.
4. Costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment vendor in the event of non-compliance.

H. Shop Drawings:

1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

2. Provide details of suspension and support for ceiling hung equipment.
3. Where walls, floors, slabs, or supplementary steel work are used for restraint locations, details of acceptable attachment methods shall be included and approved before the condition is accepted for installation.
4. Restraint manufacturer's submittals shall include spacing, and maximum static loads and seismic/wind loads at attachment and support points.
5. Indicate the type and location of piping hangers, equipment supports, seismic movement, and seismic restraints.
6. Building seismic joints and/or displacement at each level.
7. Provide specific details of restraints and anchor including number, size and locations for each piece of equipment. Annotate coordination requirements for topping slabs and embedded mechanical or electrical systems; example: radiant tubing, conduit, and sensors.

I. Quality Assurance and Control Submittals:

1. Contractor's Quality Assurance and Quality Control procedures for the administration and tracking of special inspections and testing.
2. Design Data and Test Reports.
3. Certificates and Manufacturer's Instructions.
4. Vibration and Seismic Control Product Manufacturer/Applications Engineering firm qualifications.
5. Seismic design firm's qualifications and E&O insurance certificate.
6. Seismic design engineer's professional license and seismic engineering qualifications.
7. Authority Having Jurisdiction submittal review comments and final approval notification.
8. Manufacturer's Field Reports.
9. Written verification of training.
10. Seismic Design Firm's Certification of the correctness of completed installation.

J. Review, Approvals, and Permits Required

1. Obtain written review and/or approval of from the following:
  - a. Contracting Agency - (Approval).
  - b. Authority Having Jurisdiction, AHJ - (Approval).
  - c. Architect - (Review).
  - d. Mechanical Engineer - (Review).
  - e. Electrical Engineer - (Review).
  - f. Structural Engineer - (Approval).

2. Comply with the above review comments, revising the design as required, and resubmitting in a timely manner, so as not to hinder the construction schedule.
3. Obtain and pay for required permits, inspections, tests, and approvals as required by Authority Having Jurisdiction.

K. Operation and Maintenance (O&M) Manual:

1. Provide a copy of the manufacturer's written installation, operation and maintenance manual to include the following information:
  - a. Manufacturer's descriptive literature neatly annotated to indicate information applicable to the equipment installed.
  - b. Certified seismic design calculations and installation details.

L. Close-out Submittals:

1. Project record drawings: Annotate a clean copy of the project Contract Drawings to indicate the actual installation location of each vibration and seismic restraint device type and keyed to the appropriate installation detail.
2. Provide a certificate from the seismic design firm indicating that the vibration and seismic restraint systems of the facility are installed and operational as designed.

## 1.8 QUALITY ASSURANCE

- A. Manufacturer qualifications: Company specializing in manufacturing the products specified in this section with a minimum of five years documented experience.
- B. Installers' qualifications: Minimum five years of experience in the installation of specialized vibration and seismic control systems.
- C. Seismic Design Firm: Minimum five years of experience in the design, selection, and inspection of specialized seismic control systems for facilities with similar Occupancies and seismic criteria and acceptable to the Authority Having Jurisdiction. Liability insurance and professional Errors and Omissions insurance for engineering services provided.
- D. Seismic Design Engineer: Alaska licensed professional structural engineer. Engineer shall have a minimum of 5 years of documented seismic engineering experience and acceptable to the Contracting Agency and the Authority Having Jurisdiction.
- E. Errors and Omissions Insurance Certificate:
  1. Submit copy of seismic design firm's insurance certificates.
  2. Product liability insurance certificates are not acceptable.

## 1.9 DELIVERY, STORAGE, AND HANDLING

### A. Acceptance at Site:

1. Verify vibration isolator/seismic restraint components are delivered in original factory packaging/crating and are free from damage and corrosion.
2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Contracting Agency.

### B. Storage and Protection:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.
2. Handle items to avoid damage.
3. Replace damaged items with same item in new condition.

## 1.10 WARRANTY

- A. Provide warranty in accordance with Division 1 requirements.
- B. Warranty workmanship, labor, and materials for a period of one year from the date of final acceptance, without limitation, except where longer warranty periods are specified in a specific Section under this Division, or in the General Conditions of the Contract. Promptly coordinate and perform Warranty work at the Contractor's sole expense.

## PART 2 - PRODUCTS

### 2.1 DESCRIPTION

- A. Materials and devices shall be in accordance with applicable codes and standards and shall be appropriate for intend uses.
- B. Provide vibration isolators and seismic restraint products for the project from the same manufacturer.
- C. Provide vibration and seismic application engineering design services from the same manufacturer as the products or from an approved Alaska licensed professional structural engineer.

## 2.2 MANUFACTURERS

A. Approved Manufacturers, substitutions by prior approval only. Subject to compliance with requirements, provide products by one of the named manufacturers. Substitutions will be considered for products by other manufacturers if submitted in advance of bidding in conformance with Division 1 requirements.

1. Amber Booth (AB).
2. Cooper B-Line.
3. Flex Hose.
4. Hilti.
5. International Seismic Application Technology (ISAT).
6. Kinetics Noise Control.
7. Korfund Dynamics.
8. Loose & Company.
9. Mason Industries.
10. Metraflex.
11. Thybar.
12. Tolco.
13. Unistrut, Tyco International.
14. Vibration Mountings & Controls (VMC).
15. Vibro-Acoustics.
16. Other: Pre-Approved.

## 2.3 PRODUCT CATEGORIES

A. Provide product submittals in the following categories with specific product and application identified:

1. Vibration Isolation.
2. Seismic Restraint.
3. Equipment Bases and Curbs.
4. Flexible Connectors.

## 2.4 FINISHES

- A. Provide finishes for corrosion protection:
  - 1. Exposed steel to be finished with dry powder coating for corrosion protection, galvanized, or stainless steel.
  - 2. Hardware shall be zinc electroplated, galvanized, or stainless steel. Hardware in contact with concrete and surfaces subject to liquids shall be stainless steel.
  - 3. Springs and housings shall be powder coated.
- B. In public areas exposed systems and elements shall be painted, excluding dynamic assemblies that shall have manufacturer's coating:
  - 1. Clean and prepare pipe, fittings, hangers, restraints, supports, and miscellaneous items for areas to be painted.
  - 2. Refer to the requirements specified in Division 9.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Visually inspect each location that will receive equipment and systems requiring vibration, thermal compensation, seismic control and/or wind load bracing for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement, pre-placed anchors, and cast-in-place anchors to verify actual locations before installation.
- C. Correct deficiencies prior to the installation.

### 3.2 GENERAL INSTALLATION REQUIREMENTS FOR VIBRATION ISOLATION, SEISMIC CONTROL, AND WIND RESTRAINT SYSTEM COMPONENTS

- A. Install vibration isolators, seismic control, and wind restraint systems in compliance with the manufacturer's written instructions, and certified and approved application engineering installation details.
- B. Install vibration isolators, seismic control, and wind restraints so as not to stress or misalign equipment, piping, raceways, and ductwork.
- C. Provide flexible connections for conduit, ducts, and piping for vibration isolated equipment.
- D. Coordinate installation to not degrade acoustical penetrations and vibration controls for ducts, pipes, and raceways.

- E. Do not install rigid connections between isolated equipment and building structure that degrades the noise and/or vibration controls.
- F. Submit equipment loads for pre-approval by the project Structural Engineer prior to equipment installation to avoid overstressing of the building structure. Coordinate seismic restraints with project Structural Engineer and incorporate requirements.
- G. Seismic restraint systems shall not interfere with installation or maintenance access to other building systems.
- H. Provide general bracing from structural beam flanges, upper truss cords in bar joist construction, cast in place inserts, or wedge type drill-in concrete anchors.
- I. Restraining straps or J-bolts shall be used as secondary restraint on beam clamps that support dead loads. Beam claps lacking secondary restraint features shall not be used.
- J. Install seismic cable assemblies taut on non-vibration isolated systems and with a slight amount of slack for vibration isolated systems to avoid short circuiting of isolated equipment and piping.
- K. Seismic single arm braces may be used in place of cables on rigidly attached systems and in place of cables on isolated systems when resilient bushings are used.
- L. At locations where seismic cable restraints or seismic single arm braces are located, brace support rods per manufacturer's recommendations to accept loads.
- M. At locations where seismic cable braces and seismic cable restraints are attached to pipe clevis hangers, reinforce the clevis hanger bolt with cross bolt braces or double inside nuts if required for the specific seismic acceleration levels.
- N. Provide integral vibration isolation structural steel bases as specified when required. Independent steel rails are not permitted.
- O. Conduct Special and Periodic Inspections for work under this section and submit reports in a timely basis; a maximum of 2 working days between site inspection and receipt of written report.

### 3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections or design accommodations in pipes, ducts, and raceways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

### 3.4 INSTALLATION OF EQUIPMENT

- A. Isolate and/or restraint equipment in accordance with manufacturer's recommendations.
- B. Concrete pads. Install base mounted equipment on reinforced concrete housekeeping pads or reinforced concrete pads for exterior equipment properly sized and doweled or expansion



shielded to the deck to meet acceleration design criteria. Extend pads beyond equipment base rails/floor mounting plates to meet anchor embedment requirements. Anchor equipment to housekeeping pads in accordance with certified and approved anchoring details.

- C. Install equipment bases into position (at operating height of the isolators) using temporarily supported blocks or shims prior to the installation of the equipment, isolators and restraints:
  - 1. After the installation is complete and under full load (i.e. equipment filled with operating fluid), adjust isolators to transfer load from the temporary blocks to the isolators.
  - 2. Remove blocks, shims and debris from beneath the equipment and verify that there are no short circuits of isolation. Verify the equipment is free move in all directions, within the limits of the restraints.
  - 3. Minimum operating clearance under isolated equipment is 2 inches.
- D. Protect air handling equipment and centrifugal fans from excessive displacement resulting from air thrust in relation to equipment weight. Provide horizontal thrust restraints when horizontal motion exceeds 3/8 inch.
- E. Provide earthquake ceiling clips or other approved means of positive attachment of ceiling lighting fixtures, less than 75 pounds, to the ceilings T-bar support grid. Where ceilings are not braced, provide lay-in lighting fixtures with 4 independent corner diagonal wire ties to structure.
- F. Restrain floor and wall mounted equipment and tanks with Type V restraints.

### 3.5 INSTALLATION OF PIPING, DUCTWORK, AND ELECTRICAL RACEWAYS SEISMIC RESTRAINT

- A. Seismic restraint is not required for mechanical and electrical components in Seismic Design Category D where component importance factor,  $I_p$ , is equal to 1.0 and either:
  - 1. Flexible connections between the components and associated ductwork, piping, and conduit are provided.
  - 2. Components are mounted at 4 feet or less above a floor level and weigh 400 pounds or less.
- B. High Hazard and Life Safety Systems;  $I_p$  is equal to 1.5:
  - 1. Seismically restrain High Hazard and Life Safety Systems regardless of piping diameter, etc. No exclusions for size or distance in this category.
  - 2. Other non-excluded systems include, but are not limited to:
    - a. Any fixed tanks or piping containing hazardous, flammable, combustible, toxic, or corrosive materials, which include fuel gas, fuel oil, and gasoline.
    - b. Fire pump and associated equipment, fire suppression mains and risers.
    - c. Flammable, oxidizing, oxygen depletion, and/or combustible gases and fluids which shall be contained within a closes system (i.e. any gases which pose a health hazard if released into the environment are High Hazard).

- d. Electrical: Critical, standby or emergency power components including conduit (1 inch diameter and larger) raceways, lighting, fire alarms, panels, and communication lines involving 911, etc.
  - e. Ductwork: Emergency generator exhaust; fuel fired venting, breeching, and stacks; toxics; and flammable gases.
3. For fuel oil and fuel gas piping, provide transverse restraints at 20 foot maximum intervals and longitudinal restraints at 40 foot maximum intervals.
- C. Piping, Conduit, Bus Duct, and Electrical Raceways:
1. Piping/conduit located in boiler rooms, fan rooms and other mechanical rooms that is 1-1/4 inch diameter and larger:
  2. Piping/conduit located in the remaining areas of the building that is 2-1/2 inch diameter and larger:
  3. Piping passing through two-sided sheetrock walls: If the sheetrock penetration is tight to the pipe, the penetration may act as the lateral/transverse brace for pipe sizes up to and including 4 inches provided the hole is reinforced with metal corner beading.
  4. Underground Utility Piping: For horizontal underground utility piping passing through foundation walls, provide oversized and sleeved foundation wall openings waterproofed to accommodate maximum allowable building drift and differential movement.
- D. Ductwork:
1. Chimneys, flues, and boiler breeching:
    - a. Bolt chimney, flues, and boiler breeching assemblies passing through floors at each floor level or secure above and below each floor with riser clamps.
    - b. Provide pre-engineered chimney/stack systems with seismic support assemblies as part of the integrated system when possible or separate engineered system.
  2. Restrain rectangular, round, and flat oval ductwork (of the same nominal size) with cross sectional area of 6 square feet (33 inch diameter) or larger.
  3. Brace ductwork serving a life safety function or carrying toxic materials in an “Essential or High Hazard Facility” with no exceptions and regardless of duct size or length requirements.
  4. Reinforce ductwork at each restraint location with an additional angle on top of the ductwork attached to the support hanger rods. Attach the ductwork to both upper angle and lower trapeze. Additional reinforcement is not required if duct sections are mechanically fastened together with frame bolts and positively fastened to the duct support suspension system.
  5. At duct locations supported by angles, channels or strut and requiring seismic restraint, connect seismic bracing to support in lieu of duct reinforcement.

6. A group of ducts may be combined in a single larger frame if the weights and dimensions of the smaller combined ducts are less than or equal to the maximum weight and dimensions of the duct for which the bracing system was designed.
7. Walls with duct penetrations, including gypsum board non-bearing partitions, may be used as a typical transverse duct brace if the penetration is framed with steel channel and the void space between the channel and duct is filled with blocking.
8. Components that are installed in-line with the duct system and have an operating weight greater than 75 pounds (silencers, coils, dampers, fans, heat exchangers, humidifiers) shall be supported and laterally braced independent of the duct system.
9. Unbraced piping attached to in-line equipment shall be provided with adequate flexibility to accommodate the seismic relative displacements.
10. Appurtenances less than 75 pounds such as dampers, louvers, and diffusers shall be positively attached with mechanical fasteners.

### 3.6 EXCLUSIONS

- A. Seismic restraint is not required for mechanical and electrical components in Seismic Design Category C where component importance factor,  $I_p$ , is equal to 1.0.
- B. Seismic restraint is not required for the following:
  1. Mechanical and electrical components in Seismic Design Category D, E, or F where all of the following apply:
    - a. The component importance factor,  $I_p$ , is equal to 1.0;
    - b. The component is positively attached to the structure, no free-sliding equipment;
    - c. Flexible connections are provided between the components and associated ductwork, piping, and conduit and either:
      - 1). The component weighs 400 pounds or less and has a center of mass located 4 feet or less above the adjacent floor level or
      - 2). The component weighs 20 pounds or less, or 5 pounds/foot or less for distributed systems.
  2. Conduit, Cable Tray, and Other Electrical Distribution System Raceways:
    - a. Conduit less than 2-1/2 inches in diameter.
    - b. Trapeze assemblies to support raceway less than 10 pounds/foot.
    - c. Raceway supported by hangers less than 12 inches from support point to the support structure. Rod hangers shall be equipped with swivels to prevent inelastic bending of the rod.
  3. HVAC Ductwork when the following conditions are met for the full length of each duct run where provisions are made to avoid impact with larger ducts or mechanical components or to protect ducts in the event of such impacts and:

- a. Rectangular, square, and oval ventilation ductwork less than six square feet (33 inch diameter) in cross sectional area, or weigh 17 lb/ft or less.
  - b. Ductwork supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork. Hangers detailed to avoid significant bending of the hangers and their attachments.
4. Piping Systems, excluding elevator piping:
- a. Trapeze assemblies to support raceway less than 10 pounds/foot and either, for Seismic Design Categories D, E, or F:
    - 1).  $I_p = 1.0$  the nominal pipe size is 3 inches or less, or
    - 2).  $I_p$  greater than 1.0 the nominal pipe size is 1 inches or less.
  - b. Piping supported by hangers and trapeze less than 12 inches from support point to the support structure. Rod hangers shall be equipped with swivels to prevent inelastic bending of the rod.

### 3.7 CONSTRUCTION

#### A. Interface with other Work:

1. Coordinate and sequence installation of vibration, seismic control, and wind load bracing with trades responsible for portions of this and other related sections of the Project Manual.
2. Rework required as a result of failure to follow the manufacturer's written installation instructions or properly coordinate with related Work shall be completed at no additional expense to the Contracting Agency.
3. Coordinate and schedule special and periodic inspections related to systems under this specification section.

### 3.8 REPAIR/RESTORATION

- A. Repair product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### 3.9 FIELD QUALITY CONTROL

- A. Document each installation and operational step to show compliance with this Section utilizing the approved PC/FT checklists in accordance with Section 019100 – Commissioning.
- B. Special Inspections:
  1. Independent Special and Periodic Inspections shall be performed and written reports submitted for the specific components as indicated at the expense of the Contracting Agency.

2. Special Periodic Inspections: The following systems shall require Special Inspection (SI) and Periodic Special Inspection (PSI) for seismic installation and anchorage during the course of construction for buildings in Seismic Design Categories C-F:
  - a. Electrical components for standby or emergency power systems (PSI).
  - b. Flammable, combustible, and highly toxic piping and their associated mechanical systems (PSI).
  - c. Ductwork and flues containing hazardous materials (PSI).
  - d. Equipment using combustible or toxic energy sources (SI).
  - e. Electric motors, transformers, switchgear unit substations and motor control centers (SI).
  - f. Reciprocating and rotating type machinery (SI).
  - g. Piping systems three (3) inch diameter and larger (SI).
  - h. Tanks, heat exchangers and pressure vessels (SI).
  - i. Isolators for seismic isolation systems (PSI).

C. Manufacturer's Field Services:

1. Upon completion of installation of vibration isolation/seismic restraint devices and systems, the vibration isolator/seismic restraint manufacturer's qualified representative shall inspect the completed project and certify in writing to the Contractor that systems are installed properly or provide detailed corrective action required.
2. If corrections are required, additional inspections shall be completed at by the manufacturer's representative no additional cost to the owner until the work is installed properly and certified.
3. The Contractor shall submit a report to the Contracting Agency that includes the manufacturer's qualified representative letter certifying correctness of the installation.

D. Seismic Design Firm:

1. Site verification and written certification installation is per submitted documents and completed.
2. Include photo of completed installation of equipment with tag ID annotated installed isolators and restraints, and typical installation with location annotated for ducts, pipes, and raceways.

### 3.10 CLEANING

- A. Upon completion of installation remove construction debris from around vibration isolated and seismically restrained components to allow free motion in all directions within the limits of the seismic restraining devices.

### 3.11 EQUIPMENT STARTUP

- A. During equipment start-up, verify proper installation and operation of associated vibration isolators and seismic restraints as applicable.

### 3.12 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust active height of spring isolators.
- C. Adjust restraints to permit free movement of equipment within normal mode of operation.
- D. Adjust vibration isolators and seismic restraints during equipment operation to minimize the transmission of equipment sound and vibration through the building structure and attached ductwork and piping systems.
- E. Allow for thermal compensation.

END OF SECTION 200548

## SECTION 200553 - MECHANICAL IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes:

1. Equipment Nameplates.
2. Valve Tags.
3. Valve and Equipment Directories.
4. Pipe Identification.
5. Ceiling Markers.
6. Painting of bare and insulated piping systems.

B. Related Sections:

1. 200000 - Mechanical General Requirements
2. 221100 - Domestic Water Piping and Specialties
3. 221300 - Sanitary Waste and Vent Piping and Specialties
4. 231113 - Fuel Oil Piping and Specialties
5. 231323 - Aboveground Fuel Oil Storage Tanks
6. 232113 - Hydronic Piping and Specialties
7. 232123 - Hydronic Pumps
8. 233100 - Ducts and Accessories
9. 233400 - HVAC Fans
10. 233600 - Air Terminal Units
11. 235223 - Cast Iron Boilers and Accessories
12. 236400 - Packaged Water Chillers
13. 237323 - Central Air Handling Units
14. 238123 - Dedicated Air-Conditioning Units

15. 238200 - Terminal Heating and Cooling Units
16. 238316 - Radiant Floor Heating Equipment
17. 254000 - Variable Speed Drives

## 1.2 REFERENCES

### A. Codes and Standards:

1. ANSI/ASME A13.1-2007 (American Society of Mechanical Engineers) - Scheme for the Identification of Piping Systems.
2. ANSI Z535.1-2006 (R2011) - Safety Color Code.

## 1.3 SYSTEM DESCRIPTION

### A. Design Requirements:

1. Provide equipment nameplates, valve tags and labels for the mechanical systems provided under this contract.
2. Provide labels for piping. Paint exposed piping and pipe insulation in utility and mechanical rooms.

## 1.4 SUBMITTALS

### A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

### B. Product Data:

1. Master Schedule of Equipment:
  - a. Submit master schedule of equipment, components, and systems that will be tagged and labeled for the project.
  - b. Include the proposed method of labeling to be implemented (nameplate, tag, label/marker, etc.), legend ("Domestic Cold Water," "PMP-1," etc.) and letter/background colors.
  - c. Match legend to Contract Document legend, abbreviations, and schedule symbols. Use standard mechanical identification products when available.
2. Equipment Directories: Submit separate proposed "Equipment Directories" (subset of the master schedule) for each mechanical room that includes the equipment located within the applicable space. Include system name, fluid or medium type, and normal operating properties and ranges.
3. Valve Directories: Submit separate proposed "Valve Directories" (subset of the master schedule) for each mechanical room that includes the valves located within the applicable



space. Include valve designations, a brief description and normal position (open (NO), closed (NC), balanced to X GPM). For Example:

Valve Designator	Description	Normal Position
H-101	BLR-1 Supply Isolation	NO
H-102	BLR-1 Return Isolation	NO
H-103	BLR-1 Flow Balance	150 GPM
P-100	Domestic Water Service Isolation	NO
P-201	Supply Strainer Flush Valve	NC
ETC.		

- C. Installation, Operation and Maintenance (IO&M) Manuals:
1. Provide completed, typed "Master Schedule of Equipment."
  2. Provide completed, typed "Equipment Directories."
  3. Provide completed, typed "Valve Directories" with balance valve settings obtained from the final balance report.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Marking Services Incorporated (MSI).
- B. Seton Identification Products.
- C. Craftmark.
- D. Approved equal.

### 2.2 EQUIPMENT NAMEPLATES

- A. Plastic Engraved Equipment Nameplates:
  1. Minimum letter height: 3/4 inch.
  2. Tag size: Minimum 2 inches high, length to fit equipment tag lettering requirements. Provide uniform size for similar types of equipment.
  3. Plastic thickness: 1/16 inch minimum.
  4. Fastening method:

- a. Mounting holes.
  - b. Adhesive backing may be provided for labeling equipment where drilling holes is not feasible, with the pre-approval of the Contracting Agency.
5. Color coding: As designated by the Contracting Agency. If specific direction is not provided, select white letters on black background.
  6. Legend: As designated by the Contracting Agency. If specific direction not provided, match scheduled equipment symbols.

## 2.3 VALVE TAGS

### A. General:

1. Small equipment, such as in-line pumps may be identified with tags in lieu of nameplates if inadequate room is available.
2. Provide service indicator on top line of tag, using system abbreviations provided in Part 3 Pipe Identification Table.
3. Provide valve number on bottom line of tag. Start valve numbering with "001" for each legend series/service indicator. Assign valve numbers in a logical sequence from the source (i.e. service water entry point, gas meter service isolation) or heat source (boiler or water heater supply) and continue numbering outward to the most remote terminal connection point.

### B. Plastic Engraved Tags:

1. Round, 1-1/2 inches diameter, engraved plastic.
2. Text stamped and filled black:
  - a. 1/4 inch service indicator on top.
  - b. 1/2 inch valve number below.
3. Beaded chain tag fasteners.
4. Provide tag color coding to match pipe marker coding or as designated by the Contracting Agency.

### C. Brass Stamped Tags:

1. Round, 1-1/2 inches diameter, brass with smooth edges.
2. Text stamped and filled black:
  - a. 1/4 inch service indicator on top.
  - b. 1/2 inch valve number below.
3. Beaded chain tag fasteners.

## 2.4 VALVE AND EQUIPMENT DIRECTORIES

- A. Equipment and Valve Directory Frame:
  - 1. 8-1/2" x 11" aluminum frame with plastic lens.
  - 2. Provide multiple frames as required.

## 2.5 PIPE IDENTIFICATION, MARKING

- A. Identify both service and flow direction.
- B. Colors and Lettering: Conform to ANSI/ASME A13.1; see tables under Article 3.2E below.
- C. Plastic Pipe Labels:
  - 1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering.
  - 2. Larger sizes may have maximum sheet size with plastic nylon ties or straps.
- D. Plastic Tape Pipe Labels: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

## 2.6 CEILING MARKERS

- A. Description:
  - 1. 7/8-inch diameter, color-coded.
  - 2. Metal push tacks or 0.030" rigid vinyl, pressure sensitive stickers.
- B. Color code as follows:
  - 1. HVAC equipment: Yellow.
  - 2. Plumbing valves: Green.
  - 3. Non potable water and waste water valves: Orange.
  - 4. Heating/cooling valves: Blue.
  - 5. Fire suppression valves and drains: Red.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to be painted or directly receive adhesive labels.
- B. Install identifying devices after completion of coverings and painting.

3.2 INSTALLATION

- A. Do not install identifying devices over factory installed equipment labels.
- B. Locate identifying devices in clear view for simple identification.
- C. Tag automatic controls, instruments, and relays. Key these to control system schematic drawings.
- D. Frame and install approved equipment and valve directories in each mechanical room, at a location designated by the Contracting Agency.
- E. Pipe Identification:
  - 1. Identify piping, concealed or exposed, using ANSI A13.1 compliant pipe labels. Identify both service and flow direction in accordance with the following table:

Abbreviation	Legend	Color (Letters/Background)
CW	Domestic Cold Water	White/Green
HW	Domestic Hot Water	White/Green
HWC	Domestic Hot Water Circulation	White/Green
HWS	Heating Water Supply	White/Green
HWR	Heating Water Return	White/Green
GHS	Glycol Heating Supply	White/Green
GHR	Glycol Heating Return	White/Green
RL	Refrigeration - Liquid	Black/Orange
RS	Refrigeration - Suction	Black/Orange
FOS	Fuel Oil Supply	White/Brown
FOR	Fuel Oil Return	White/Brown
ARV	Acid Resistant Vent	Black/Orange
ARW	Acid Resistant Waste	Black/Orange
W	Sanitary Drain	White/Green
V	Sanitary Vent	White/Green

Abbreviation	Legend	Color (Letters/Background)
RL, ORL	Rain Leader, Overflow Rain Leader	White/Green
SD	Storm Drain	White/Green
FW	Fire Suppression Water	White/Red
CA	Compressed Air	White/Blue

2. Pipe label letters shall be a minimum of 1/2-inch high and increase with pipe diameter as follows:

Pipe Outside Diameter	Letter Height
0.75" to 1.25"	0.5"
1.5" to 2"	0.75"
2.5" to 6"	1.25"
8" to 10"	2.5"
over 10"	3.5"

3. Install labels in unobstructed view and aligned with horizontal or vertical axis of piping as appropriate. For piping located above the normal line of vision, place labels below the horizontal centerline of the pipe for clear unobstructed view from below.
4. Install labels not to exceed 20 foot intervals along straight piping runs (including risers and drops), close to valves, adjacent to changes in direction and branches, on each side of pipe penetrations through walls or floors, and at each access panel.
5. Pipe labels are not required on exposed pipes in public spaces unless specifically indicated.

F. Pipe Painting:

1. Paint piping insulation exposed in public areas in accordance with Division 09 - Finishes.
2. Paint bare steel piping exterior to the building gray in accordance with Division 09 - Finishes.
3. Do not paint non-ferrous piping/tubing, fittings or valves such as copper or bronze.

END OF SECTION 200553

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## SECTION 200556 - INTERIOR TRENCH EXCAVATION AND BACKFILL

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This section describes general requirements, products, and methods of execution relating to excavation, back-fill, and compaction of inside trenches for mechanical work. Inside trenches are those which occur within an arbitrary, imaginary boundary five feet beyond the outside perimeter of the structure.
- B. Related Sections:
  - 1. 200000 - Mechanical General Requirements
  - 2. 221100 - Domestic Water Piping and Specialties
  - 3. 221300 - Sanitary Waste and Vent Piping and Specialties
  - 4. 231113 - Fuel Oil Piping and Specialties
  - 5. 232113 - Hydronic Piping and Specialties
  - 6. 233100 - Ducts and Accessories

#### 1.2 SYSTEM DESCRIPTION

- A. Provide trench work for mechanical work of every description and of whatever substance encountered to the depth indicated, or to provide pipe slopes and elevations shown on the Drawings. Excavate and backfill utility trenches. Place and compact bedding material. Compact backfill material.

### PART 2 - PRODUCTS - NOT USED

### PART 3 - EXECUTION

#### 3.1 TRENCH BACKFILL

- A. Obtain trench backfill material from trench excavation. If sufficient suitable trench backfill material is not available from trench excavation, import it from sources approved by the Contracting Agency.
- B. Use granular material, free from large stones, boulders, debris, and frozen material. Maintain moisture content within a range that will allow specified compaction.

### 3.2 EXCAVATION

- A. Place excavated material suitable for back-fill in an orderly manner, and in conformance with safety codes.
- B. Dispose of material not suitable for back filling.
- C. Form bell holes so pipelines rest on continuous undisturbed soil. If larger rocks or boulders are encountered, remove them. If trenches are below specified grade, backfill to required depth with select granular materials free from debris, rock, or frozen material, and compact to proper grade before installing piping.

### 3.3 LOCATION

- A. Locate trenches to accommodate utilities shown on the drawings.
- B. Excavate trench with adequate width to allow compaction equipment to be used at the sides of pipes.
- C. Make trench side slopes conform to prevailing safety code requirements.

### 3.4 DEWATERING

- A. Perform whatever work is necessary to prevent the flow and accumulation of surface or ground water in the excavation.

### 3.5 TIMING

- A. Do not back-fill until underground mechanical system has been properly tested, inspected and approved.
- B. Coordinate with the work of others, and complete trench work in a timely manner.

### 3.6 BEDDING MATERIAL

- A. Select bedding material from trench excavation using care to separate it from unsuitable material. If suitable bedding material is not available from trench excavation, import it from sources approved by the Contracting Agency.
- B. Use granular material, free from large stones, boulders, debris, and frozen material. Maintain moisture content within a range that will allow specified compaction.
- C. Do not use any frost susceptible materials.



### 3.7 BEDDING

- A. Place bedding material under, around, and over the pipe in lifts not exceeding six inch in depth.
- B. Work material around pipe by hand methods, taking care to keep any oversize or sharp stones out of contact with the pipe, and to provide uniform support for the pipe.
- C. Cover pipe with bedding material to building sub-grade or to a minimum 12-inch depth before adding other backfill.

### 3.8 BACKFILLING

- A. Continue placing backfill material until trench is completely filled to building sub-grade, or as shown on the Drawings.
- B. Place backfill material in lifts not to exceed 6-inches in depth.

### 3.9 COMPACTION

- A. Compact bedding material to at least 95 percent of maximum density, taking care not to damage the pipe.
- B. Compact backfill under footings, slabs, and other structures to 95 percent of maximum density or more, if required by the Contracting Agency. Where 95 percent compaction cannot be achieved, fill remaining voids with concrete. Provide compaction tests every 100 feet.
- C. Compact other areas to preclude future settlement, or at least to 85 percent of maximum density.

### 3.10 FINISHING

- A. After completion of backfilling, dispose of excess material and smooth the surface to grade.
- B. Do not allow heavy equipment to be used over backfilled work that does not have sufficient cover to prevent pipe damage.

### 3.11 SPECIAL PRECAUTIONS

- A. Avoid unauthorized and unnecessary excavations.
- B. Minimize number and size of excavations under footings or bearing walls.
- C. Support footings, foundations, and walls with timbers and jacks if there appears to be any possible chance of damage and keep such precautions in place until work is completed and sufficient backfill is in place to eliminate possible damage.

- D. Avoid damage to existing underground services, cables, conduit lines or foundations. Repair any existing underground work damaged at no additional cost to the Owner.
- E. Protect excavated materials from moisture during the period prior to reinstallation.

END OF SECTION 200556

## SECTION 200700 - MECHANICAL INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Specific requirements, products and methods of execution which relate to the insulation of ducts, fittings, equipment, pipes and other surfaces of the mechanical installation.
- B. Related Sections:
  - 1. 200000 - Mechanical General Requirements
  - 2. 221100 - Domestic Water Piping and Specialties
  - 3. 221300 - Sanitary Waste and Vent Piping and Specialties
  - 4. 224000 - Plumbing Fixtures and Equipment
  - 5. 232113 - Hydronic Piping and Specialties
  - 6. 233100 - Ducts
  - 7. 238316 - Radiant Floor Heating Equipment

#### 1.2 DESCRIPTION

- A. Provide thermal insulation for ventilation system ductwork and building service piping.
- B. Provide insulation for exposed ADA plumbing fixture piping.

#### 1.3 REFERENCES

- A. International Building Code (IBC).
- B. International Mechanical Code (IMC).
- C. International Energy Conservation Code (IECC).
- D. ASHRAE 90.1 - 2010 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. NFPA 90A - 2002 Standard for the Installation of Air Conditioning and Ventilating Systems.
- F. NFPA 90B - 2006 Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

- G. MSS Standard Practice SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

#### 1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Qualifications: Submit manufacturer and Applicator qualifications, showing compliance with Article 1.5.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.
- B. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years' experience.

#### 1.6 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient conditions required by manufacturer of each product.

### PART 2 - PRODUCTS

#### 2.1 FIRE RATING OF MATERIALS

- A. Provide insulation products used aboveground in building with burning characteristics in compliance with NFPA Standards 90A and 90B: Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Tested according to UL 723, ASTM E84, or NFPA 255.
- B. Insulation specified for use underground and aboveground away from the building might have other burning characteristics. Use such products only where specifically required.

#### 2.2 FIBERGLASS INSULATION

- A. Provide piping insulation products as follows:
  - 1. Thermal conductivity K equals 0.24 at 100 degrees F. mean temperature, ASTM C335.
  - 2. Factory applied vapor-barrier, flame retardant all service jacket and tape, with permeability rating equal to 0.02 perms, ASTM E96.
  - 3. Temperature limits for fiberglass pipe insulation: 350 degrees F, unless otherwise indicated.

4. Manufacturers: Johns Manville, Owens Corning, Knauf Fiber Glass, or approved equal.

B. Provide ductwork insulation products as follows:

1. Flexible insulation: Average thermal conductivity K equals 0.24 at 75 degrees F. mean temperature at 1.5 pcf density, ASTM C335.
2. Rigid insulation: Average thermal conductivity K equals 0.24 at 75 degrees F. mean temperature at 3.0 pounds per cubic feet (pcf) density, ASTM C518.
3. Factory-applied vapor barrier flame-retardant Foil-Scrim-Kraft (FSK) or all-service jacket and tape, with permeability rating equal to 0.02 perms, ASTM E96.
4. Temperature limits for fiberglass duct insulation: 250 degrees F. unless otherwise indicated.
5. Manufacturers: Johns Manville, Owens Corning, Certainteed, Knauf Fiber Glass, or approved equal.

### 2.3 FLEXIBLE FOAM PLASTIC

- A. Thermal Conductivity: 0.27 at 75 degrees F mean temperature, ASTM C518.
- B. Water Vapor Transmission: 0.08.
- C. Flame-spread rating of 25 or less and a smoke-developed rating of 50 or less as tested by ASTM E 84.
- D. Manufacturer: Armaflex, Aerotube, Rubatex.

### 2.4 FIXTURE INSULATION ASSEMBLY

- A. Manufacturer: Proflo PF200 Series, or approved equal.
- B. Description: Protective single piece cover manufactured specifically for plumbing fixture supplies and drains.
- C. Performance/Design Criteria:
  1. Burning characteristics: Self-extinguished zero seconds per ASTM D-635.
  2. Bacterial/Fungus Resistance: Zero growth per ASTM G21 and G22.
- D. Material: Molded vinyl with 1/8 inch wall, internal and reusable fasteners, and tool-less tear-to-fit trim feature.

## 2.5 CANVAS JACKETING

- A. Insulating Lagging Canvas: Eight ounces per square yard minimum, fire-retardant material complying with fire ratings specified above. Manufacturer: Chas Harmon "Osnaberg", Claremont Company Inc., "Claretex", or approved equal.
- B. Lagging Adhesive: Plastic synthetic resin emulsion adhesive; watertight, mildew resistant, fire retardant. Manufacturer: Childers Chil-Perm CP or approved equal.

## 2.6 METAL JACKETING

- A. 27 gauge (U.S. Standard) heavy corrugated aluminum.
- B. Preformed fitting covers.

## 2.7 COATINGS

- A. Coatings: UL labeled.
- B. On cold or dual service lines, use vapor barrier type coatings.

## 2.8 PREFORMED FITTING COVERS

- A. One piece premolded PVC jacketing and fitting covers specifically designed for the service intended.
- B. Install per manufacturer's instructions and secure with manufacturer's color matching PVC tape.
- C. Manufacturer: J-M "Zeston", TeeCee, Proto, Certainteed.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Do not apply insulation materials until surfaces to be covered are clean and dry and foreign material such as rust, dirt, etc. is removed. Keep insulation clean and dry during installation and during the application of any finish.
- B. Do not install the insulation on pipe fittings and pipe joints until the piping has been tested and approved.
- C. Do not install the insulation on ducts or fittings until the ductwork has been tested and approved.
- D. Do not apply under conditions of excessive humidity or at temperatures below 50 degrees F. or above 100 degrees F.

- E. Provide insulation support blocks, shields, and transitions for hangers, supports, anchors, and guides. Coordinate insulation requirements through rated assemblies and Listing penetration's requirements.
- F. Adjust hangers, guides, anchors, and supports after insulation installation has been approved.

### 3.2 PIPE INSULATION

#### A. Cold Piping:

- 1. Includes domestic cold water, plumbing and other vents through roof, chilled water, heat recovery, refrigeration, and other cold piping to zero degrees F.
  - a. Insulate plumbing vents from three feet below the under deck of the roof to the termination above the roofline.
- 2. Insulate with sectional fiberglass and provide a completely sealed vapor barrier. Provide insulation thickness per Insulation Thickness Table.
- 3. Insulate valves, unions, flanges, fittings, tanks, vessels, air separators, heat exchangers, and similar components, except where indicated otherwise.

#### B. Hot Piping:

- 1. Includes domestic hot water supply and recirculation and hydronic heating.
- 2. Insulate with sectional fiberglass. Provide insulation thickness per Insulation Thickness Table.
- 3. Insulate valves, unions, flanges, fittings, tanks, vessels, air separators, heat exchangers, and similar components, except where indicated otherwise.

#### C. Buried Piping. Insulate with flexible foam plastic insulation; glue seams with manufacturers recommended cement.

#### D. In addition to specified jackets, provide heavy corrugated aluminum jacket on piping insulation anywhere piping is exposed below eight feet zero inches above floor in public areas.

#### E. Insulation Thickness Table (units are in inches):

Fluid Design Operating Temperature Range	Less than 1	1 to <1-1/2	1-1/2 to <4	4 to <8	8 and up
<b>Heating Systems (Water and Glycol Solutions) and Domestic (Hot Water and Hot Water Circulation):</b>					
141 °F to 200 °F	1.5	1.5	2	2	2
105 °F to 140 °F	1.5	1.5	2	2	2
<b>Cooling Systems (Chilled Water and Glycol Solutions, and Refrigerant):</b>					

Fluid Design Operating Temperature Range	Less than 1	1 to <1-1/2	1-1/2 to <4	4 to <8	8 and up
40 °F to 60 °F	1.5	1.5	1.5	1.5	1.5
Below 40 °F	1.5	1.5	1.5	1.5	1.5
Heat Recovery Systems (Water and Glycol Solutions):					
35 degrees F to 90 degrees F	1	1	1.5	1.5	1.5
Domestic Cold Water:					
All	1	1	1.5	1.5	1.5
Rain leaders, Plumbing vents through roof:					
All	1	1	1.5	1.5	1.5

### 3.3 TECHNIQUE FOR APPLICATION TO PIPES

- A. Close longitudinal joints of pipe insulation firmly and butt insulation sections firmly together. Neatly and smoothly adhere laps and butt strips.
- B. Clean the contact area on jacket for adhesive lap strips and butt strips so it is free from fingerprints, oil, construction dust and other contaminants. Clean surfaces with tack rags, methanol, or other suitable agent before attempting to adhere the strip. Apply pressure to adhesive strip with suitable tool immediately after adhering. Remove insulation with inadequately sealed joints and install new sections. Outwardly clinching staples may be used to reinforce joints.
- C. Continuously seal vapor barriers. If staples are used at laps, seal the entire length of stapled lap with adhesive jacket tape applied as specified above for laps and butts. Sectionalize vapor barrier by sealing ends of insulation sections at not more than 25 feet intervals, to prevent moisture migrating lengthwise. Apply butt strips over joint as above.
- D. Provide double insulation thickness on piping in outside walls and within five feet of vehicle doors or other large openings.
- E. Except as indicated, locate pipe hangers and rollers outside insulation. Provide insulation saddles or sheet metal shields around insulation. On pipes two inches and larger, within the area of each insulation shield, use calcium silicate or cellular glass on the lower half of the insulation, equal in thickness to adjacent insulation.
- F. Where piping is installed outdoors, provide two-layer glass cloth and four-layer weatherproof vapor barrier adhesive coating, in addition to jacket specified.

### 3.4 TECHNIQUE FOR APPLICATION TO PIPE FITTINGS, UNIONS, FLANGES,EQUIPMENT, AND VALVES

- A. Insulate fittings, valves, and flanges to the same thickness as the pipe insulation.
- B. Any of the following methods of insulation are acceptable:



1. Blanket Wrap: Wrap the fitting with compressed glass fiber blanket. Wire the blanket securely in place and cover with a smooth layer of insulating/finishing cement. Cover with glass mesh tape, adhering it with an adhesive coating.
  2. Fabricated Segments: Cut mitered segments from pipe insulation that has the same wall thickness as adjacent pipe insulation to form a cover which will fit snugly around the fitting. Wire the segments firmly in place and seal the joints with insulating/finishing cement. Apply adhesive coating and wrap with glass mesh tape, then apply another layer of the same coating over the whole assembly.
  3. Cement: Apply insulating or insulating/finishing cement, molding it to the contour of the fitting. When area is large, apply an under layer of cement, wrap this with glass mesh tape, then apply an outer layer of cement. If the insulation is not concealed the exposed surface of insulating/finishing cement shall have a final glass mesh tape wrap embedded in adhesive.
- C. In each of the listed methods, to protect the insulation against contact damage, apply an adhesive coating when the cement is completely dry and hard, then wrap with glass mesh tape. Apply another coating of adhesive over the whole assembly.
- D. In each of the listed methods, pre-formed fitting covers may be substituted for the tape and adhesive covering specified. Cement and tape fitting covers on cold piping to provide a positive vapor barrier.
- E. Removable insulation blankets of comparable insulation value for valves and where equipment require frequent adjustments or maintenance shall be provided; identify and coordinate during submittal process.
- F. After insulation has been installed adjust hangers for proper fit, maintain pipe grade and support.

### 3.5 DUCT THERMAL INSULATION REQUIREMENTS

- A. Insulate ductwork as follows:
1. Insulate outside air intake ducts from air intake louver connection to equipment connections (including insulated isolation damper frame) with 2-inch rigid or semi-rigid board insulation.
  2. Insulate exhaust and relief ducts from point of discharge to and including two-position motorized damper support frame with 2-inch rigid or semi-rigid board insulation.
  3. Supply air ductwork: When mechanical cooling is provided, insulate associated ventilation system supply ductwork from AHU connections to VAV terminal unit inlet connections with 1-1/2 inch thick fiberglass insulation.
  4. Return air ductwork: Insulate return air ductwork passing through unheated spaces, within in mechanical rooms and as indicated with 1-1/2 inch fiberglass insulation.

5. Lined ductwork: Provide external duct insulation only when indicated in addition to duct lining.

B. Insulation Type and Finish:

1. Rigid or semi-rigid board where canvas or metal jacket is specified. May also be used in place of blanket insulation where practical.
2. Blanket insulation where rigid board is not specified or indicated. Proper installation is critical. Loose joints and sagging insulation shall require re-insulation of entire branch or main duct before acceptance and during warranty period.
3. Fiberglass or canvas jacket over board insulation in mechanical and boiler rooms less than 10 feet above finish floor, where exposed in finished rooms and where indicated. Seal jacket with vapor barrier lagging adhesive.
4. Ductwork insulation to have a completely sealed vapor barrier, except segmental insulation on medium/high velocity trunk ducts and warm air ducts in concealed spaces, where approved.

### 3.6 TECHNIQUE FOR APPLICATION TO DUCTWORK

A. Rigid and Semi-rigid Insulation:

1. Impaling Over Pins: Install insulation with edges tightly butted using adhesive and metal pins. Impale insulation on pins welded to the duct and secure with speed clips. Trim off pins close to speed clip. Space pins as required to hold insulation firmly against duct surface but not less than one pin per square foot.
2. Other Method of Securement: If the welded pin method is not feasible, secure the insulation to the duct with adhesive. Cover the entire surface of the metal with adhesive when applying to the underside of horizontal ducts. Application to top and sides may be in strips with a minimum of 50 percent coverage. Additionally, secure insulation with No. 16 galvanized wire on not more than 12 inches on center. Provide metal angle at corners to protect edges of insulation.
3. Vapor Barrier: Seal joints and speed clips with adhesive tape of similar construction to insulation jacket. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique. Glass cloth tape set in adhesive may be used. Provide metal or plastic corner angles within eight feet of floor, walkway, or stairs.
4. Provide fiberglass or canvas jacket where specified. Completely cover with minimum 1/8" lagging adhesive. Cover canvas with two heavy coats of same adhesive and completely fill the weave. Inspect when dry for complete vapor barrier throughout and refinish as required.

B. Blanket Insulation:

1. Position insulation so that longitudinal seam will be underneath and not supporting weight of sheet. Remove a uniform strip of insulation from backing to provide a lap strip. Butt insulation and secure lap strip with outwardly clinching staples.
2. Use pins to secure blanket on large flat areas as specified for rigid insulation. Reinforce jacket at pin penetration where required.
3. Seal laps, staples and butt joints with adhesive tape of similar construction to insulation jacket. Seal speed clips if used. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique.
4. When system is under pressure, inspect insulation for inflation caused by improperly sealed ducts. Repair duct seal and reinsulate as necessary.
5. The Contracting Agency may inspect completed insulation and test taped joints for adhesion. Seal laps and butt tapes that can be removed with reasonable force shall require that entire branch or trunk duct be reinsulated.

### 3.7 FIXTURE INSULATION ASSEMBLY

- A. Insulate hot water and cold water supply and waste piping exposed beneath sink and lavatory fixtures designated on drawings or specified in Section 224000 - Plumbing Fixtures, as intended for use by the handicapped.
- B. Install in accordance with ANSI A117.1. - 2009.

END OF SECTION 200700

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