

SECTION 230548 – MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL

PART 1 - GENERAL

1.01 BUY AMERICAN REQUIREMENTS

- A. Provide certificates to show that all products meet the following requirements.
 - 1. American Iron and Steel (AIS)
 - 2. Build America, Buy America Act
- B. See Supplementary Conditions for details.

1.02 SUMMARY

- A. Section Includes:
 - 1. Bases.
 - 2. Vibration isolators.
 - 3. Seismic Restraints.
 - 4. Duct attenuators.
 - 5. Ductwork lagging.

1.03 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- B. American National Standards Institute:
 - 1. ANSI S1.4 - Sound Level Meters.
- C. American Society of Heating, Refrigerating and:
 - 1. ASHRAE Handbook - HVAC Applications.
- D. American Society for Testing and Materials:
 - 1. ASTM C94 - Standard Specifications for Ready-Mixed Concrete
- E. Sheet Metal and Air Conditioning Contractors':
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
 - 2. SMACNA – Seismic Restraint Manual.

1.04 PERFORMANCE REQUIREMENTS

A. General:

1. Provide resilient earthquake restraints with suitable structural support for all vibration isolated equipment and piping as specified herein and shown on the drawings and in the vibration isolation schedule.
2. Restraints shall be attached to structural members capable of withstanding the design dynamic load specified below.
3. Contractor shall be responsible for ensuring that the dynamic load capacity of the attachment bolts and supporting structure is greater than or equal to the capacity of the seismic restraint.
4. Contractor shall also coordinate the size of concrete piers and housekeeping pads to ensure adequate room for the isolators and the restraints.
5. Design of the seismic restraints shall be stamped and signed by a registered civil or structural engineer.
6. Design, Select and size equipment, braces, supports and anchors.
7. Accommodate vibration and thermal movement.
8. Restraint to meet IBC requirements.

- B. Work under this section shall include furnishing all labor, material, tools, and equipment necessary for the complete installation of all vibration isolation and seismic restraint for mechanical equipment, piping, ductwork, and stacks as specified and shown. Methods and materials specified in this section are minimum requirements and shall not excuse the Contractor from the responsibility of meeting the criteria specified. All changes and additions required to meet the criteria shall be made without cost to the owner. Peak vibration velocities measured on the bearing caps of rotating equipment shall not exceed 0.08 ins/sec when the equipment is running at its operating speed.

- C. To qualify for approval, manufacturer shall certify in writing that he has the required engineering and testing facilities, and registered engineering personnel.

- D. A single manufacturer shall furnish all isolation products including steel bases and inertia base forms. Exceptions: Canvas or lead vinyl duct connections, and concrete in inertial bases. Also excepted is the provision of spring isolators installed as an integral part of equipment mounted within cabinets fabricated by the equipment manufacturer, e.g., internally isolated air handling units. Notwithstanding, all of the isolators shall conform to the product requirements of these specifications.

- E. The manufacturer is responsible for the following:

1. Selecting vibration isolators and seismic control devices meeting Contract Document requirements.
2. Furnishing shop drawings.
3. Coordinating selection of piping supports with equipment supports to maintain uniformly efficient isolation throughout each system, while accommodating vibration, expansion, and contraction, without creating excessive stresses and objectionable noises at equipment connections, ductwork, or in piping.
4. Reviewing equipment manufacturer's literature and ensuring that procedures for setting and adjusting all isolation devices are in accord with recommendations.

- F. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping and ductwork.
- G. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.
- H. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook, HVAC Applications.

Mechanical Spaces

OSHA

1.05 SUBMITTALS

- A. Submit under the provisions of Division 01 and Section 230100 – General Mechanical Requirements.
- B. Shop Drawings:
 - 1. Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Drawings of all bases showing dimensions, center of gravity of the equipment, individual isolators for each support point, details of mounting brackets for isolators, location for all equipment mounting bolts and size and locations of concrete supports for the isolators.
 - 2. Drawings and details showing the capacity, location, and arrangement of seismic restraints.
- C. Product Data: Submit schedule of vibration isolator type including model number with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- D. Seismic restraint designs and/or model number.
- E. Detailed calculations showing the weight distribution for each equipment support point (as calculated, not averaged), and calculations showing the loads at each isolator.
- F. Size, type, load, and static deflection for each isolator.
- G. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- H. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.
- I. All submittals shall be stamped and signed by the manufacturer's registered professional engineer.

1.06 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Division 01 and Section 230100 – General Mechanical Requirements.
- B. Project Record Documents: Record actual locations of hangers and seismic restraints including attachment points.

1.07 SPECIAL QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience and engineering, testing facilities, and registered engineering personnel.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

PART 2 - PRODUCTS

2.01 BASES

- A. Manufacturer:
 - 1. Mason Industries.
 - 2. Amber Booth.
- B. General:
 - 1. All bases shall be sized to include equipment and motor without overhang.
 - 2. Structural beam or channel members shall form the perimeter framing. Beam depth shall be at least 1/12th of the longest span. Spans less than 6 feet shall have a beam depth of 6 inches. Welded steel end closure over ends of I beams.
 - 3. Use diagonal beams or channel braces equal to 1/2 the depth of the perimeter beam when the longest beam dimension exceeds 8 feet.
 - 4. Provide earthquake bumpers to prevent excessive motion during starting and for earthquake bracing. Bumpers shall be installed after equipment is in operation to allow proper placement and alignment and to ensure that the bumpers are not engaged during normal system operation.
 - 5. Motor driven equipment shall be mounted with motors on a common base of sufficient rigidity to maintain permanent alignment.
 - 6. All bases shall have clearance of 1-1/2 inches between top of floor and underside of base.
- C. Mounting Brackets MB-1: Mounting brackets sized to match vibration isolator and designed to mount directly to structural frame of mechanical equipment without the use of a separate structural steel frame.
- D. Equipment Base SB-1:
 - 1. Structural steel rectangular base with cross members to prevent twisting where longest beam dimension exceeds 6 feet.
 - 2. Use welded steel and closure plates over the end of the I-beams for stiffness.
 - 3. Use height-saving brackets for side mounting of isolators.
 - 4. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
 - 5. Construction: Welded structural steel with gusset brackets, supporting equipment and motor with motor slide rails.

2.02 VIBRATION ISOLATORS

A. Manufacturers:

1. Mason Industries.
2. Amber Booth.

B. Steel Spring Isolators:

1. General:

- a. Required types of springs and spring deflections for isolators supporting various pieces of equipment are tabulated in the vibration isolation schedule in this section.
- b. All isolators for a single piece of equipment shall have approximately equal spring deflection.
- c. Ends of springs shall remain parallel during deflection.
- d. For each spring, provide a built-in leveling bolt.
- e. Equipment must be mounted absolutely level.
- f. All springs must be selected for additional 50 percent capacity to solid.
- g. Provide sheet neoprene pad, Type E-1, minimum 1/4-inch thick, bonded to the underside of the baseplate or spring to serve as a noise breaker. Select pad area and durometer to achieve a static deflection between 0.04 and 0.06 inches.
- h. Isolators installed out of doors shall be designed to provide restraint due to wind loads of 30 pounds per square foot, applied on surface of equipment, without failure.
- i. Installed isolators shall be adjustable and easily removed for replacement.
- j. Use height saving brackets as required to achieve 1 inch of clearance (+/- 1/2 inch) between base and housekeeping pad.
- k. Springs must be rigidly attached, by welding or other approved means, to baseplate and top plate, except for spring hangers.
- l. Springs shall be designed for minimum ratio of horizontal to vertical spring stiffness of 0.8 and minimum ratio of spring diameter to spring operating height of 0.8.
- m. All floor-mounted spring isolators shall have bolt holes in bases and be anchored to structure with isolated restraining bolts. Isolate bolts from base with neoprene grommets and neoprene washers. Anchor bolts shall not compress neoprene grommets and washers more than 10 percent of normal thickness.
- n. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
- o. Code: Color-code springs for load carrying capacity.

2. Freestanding Springs S-1:

- a. Adjustable, freestanding, open steel spring mounting with top and base plates designed to allow rigid attachment to the machinery frame and supporting structure, respectively.
- b. Used for equipment that does not encounter weight removal or wind loads.
- c. Neoprene pad must be located under the baseplate and not between the baseplate and spring.
- d. Manufacturer:
 - 1) Mason SLF.
 - 2) Amber Booth.

3. Restrained Springs Type S-2:
 - a. Adjustable open spring isolator, similar to Type S-1, with a frame to include vertical resilient limit stops to prevent spring extension when weight is removed.
 - b. For equipment whose operating weight may differ from installed weight.
 - c. Mounts shall be designed with fail-safe feature to protect against wind loads and overturning of mounts in earthquakes.
 - d. Mounts shall be capable of withstanding lateral accelerations of 1g. Allow 1/2 inch clearance around vertical restraining bolts, with neoprene grommets and washer to prevent restraining bolts from short-circuiting isolation. Limit stops must be out of contact during normal operation.
 - e. Manufacturer:
 - 1) Mason SLR.
 - 2) Amber Booth.
4. Spring Hanger Type SH-1:
 - a. Steel box frame, open on two sides, containing an open steel spring capable of supporting twice the rated load without reaching the yield point.
 - b. Spring mounted in a molded neoprene isolation bushing.
 - c. Spring diameters and lower hole sizes large enough to permit hanger rod to swing through 30-degree arc before contacting hole and short-circuiting spring.
 - d. Provide hole in top of box for bolting to structure.
 - e. Misalignment: Capable of 20-degree hanger rod misalignment.
 - f. Submittals shall include scale drawing of hanger showing misalignment capability.
 - g. Manufacturer:
 - 1) Mason HS.
 - 2) Amber Booth.
5. Spring Hanger Type SH-2:
 - a. Same as SH-1, but hanger shall be pre-compressed to the rated deflection to keep equipment or piping at fixed elevation during installation.
 - b. Hangers shall have release mechanism to free spring after installation is complete and hanger is subjected to full load.
 - c. Manufacturer:
 - 1) Mason PCHS.
 - 2) Amber Booth.
6. Thrust Restraint Type TR-1 (Compression):
 - a. Horizontal thrust restraint. Two units per fan.
 - b. Spring assembly with rods, clips, and miscellaneous hardware.
 - c. Reinforce plenum partition with 2-1/2-inch x 2-1/2-inch x 1/4-inch channels to withstand force of thrust restraint.
 - d. Install in compression.
 - e. Manufacturer:
 - 1) Mason WBI.
 - 2) Amber Booth.

C. Neoprene Isolators:

1. General:

- a. Neoprene rubber mounts and pads shall contain a minimum 5 percent pure neoprene rubber.
- b. When used in locations that prevent easy replacement, use bridge bearing stock that contains a minimum 40 percent pure neoprene rubber.
- c. Use 40 durometer unless otherwise specified or required.

2. Sheet Neoprene Pads Type E-1:

- a. Pad mounting consisting of one or two layers approximately 5/16-inch-thick ribbed or waffled neoprene pads bonded to a galvanized steel load distribution plate.
- b. Thickness of the load distribution plate shall be sufficient to evenly distribute (± 10 percent) the load over the entire pad.
- c. Pad must be furnished with sufficient area to achieve the static deflection shown in the schedule.
- d. If anchoring is mandatory, provide neoprene grommets and washers to prevent anchor bolt from short circuiting isolation.
- e. Manufacturer:
 - 1) Mason MWM.
 - 2) Amber Booth.

3. Waffle Pad Type E-2:

- a. Neoprene waffle pad, top and bottom, with cork sandwiched between neoprene layers.
- b. Thickness of the load distribution plate shall be sufficient to evenly distribute (± 10 percent) the load over the entire pad.
- c. Pad must be furnished with sufficient area to achieve the static deflection shown in the schedule.
- d. If anchoring is mandatory, provide neoprene grommets and washers to prevent anchor bolt from short circuiting isolation.
- e. Manufacturer:
 - 1) Mason NK.
 - 2) Amber Booth.

4. Neoprene Hangers Type E-3:

- a. Cone-shaped elastomeric mounting made from neoprene with a box frame similar to isolator Type SH-1.
- b. Hanger rod shall penetrate neoprene element and steel frame with sufficient clearance to allow it to swing through a 30-degree arc before contacting neoprene bushing at the perimeter of the hole in the frame.
- c. Provide hole in the top of the box for bolting to structure.
- d. Submittals shall include scale drawing of hanger showing misalignment capability.
- e. Manufacturer:
 - 1) Mason HD.

2) Amber Booth.

5. Neoprene Impregnated Washers and Bushings Type E-4:

- a. Use washers and bushings to eliminate direct contact between bolt and equipment.
- b. Washers shall consist of multiple-layer neoprene-impregnated duck.
- c. Washer thickness should be 1/4 inch, with maximum loading not to exceed 1000 psi.
- d. Bushings shall consist of neoprene-impregnated duck tube.
- e. Manufacturer:
 - 1) Washers, Mason HLW, Bushings, Mason HLB.
 - 2) Amber Booth.

6. Pipe Anchors and Guides Type E-5:

- a. Directional acoustical pipe anchors and guides for vertical piping consisting of telescopic arrangement of two sizes of steel tubing separated by minimum 1/2-inch thickness of heavy-duty neoprene and neoprene isolation material.
- b. Vertical restraints shall prevent vertical travel in either direction.
- c. Allowable loads on isolation materials shall not exceed 500 psi and design shall be balanced for equal resistance in any direction.
- d. Manufacturer:
 - 1) Mason ADA.
 - 2) Amber Booth.

7. Neoprene Mounting with Captive Steel Inserts Type E-6:

- a. Captive neoprene mountings shall consist of a steel housing with a captive steel insert embedded in neoprene to prevent contact between the housing and the central threaded insert. Bonded assemblies without mechanical interlocks are not acceptable.
- b. All mountings shall have at minimum 1.0 horizontal G ratings. All mountings shall have bolts for rigid attachment to the equipment and adequate base bolting provision. Mountings shall have a minimum static deflection of 0.15 inch.
- c. Manufacturer:
 - 1) Mason RBA, RCA, or RDA.
 - 2) Amber Booth.

D. Flexible Connectors:

1. General:

- a. Flexible connectors shall be constructed of flexible stainless steel hose and shall have stainless steel braid and carbon steel fittings. Sizes 3 inches and larger shall be flanged.
- b. Connector shall be terminated at both ends with either a flange or threaded fitting.
- c. Connectors shall have a minimum burst pressure of 500 psi and a recommended maximum operating pressure that is greater than the design operating pressure at the temperature of the fluid.
- d. All piping shall be properly aligned prior to the installation of the flexible connectors.

- e. Flexible connectors shall not be used to compensate for misalignment of the piping.
- f. Manufacturer:

- 1) Mason Type BSS.
- 2) Amber Booth.

2. Flex Connector Type FC-1:

- a. Neoprene connector that incorporates a 90-degree elbow turn.
- b. Design shall be such as to allow relative movement between the flanges in any direction up to 0.625 inch.
- c. Recommended maximum operating pressure shall be at least 150 psi at temperatures below 220 deg F.
- d. Manufacturer:

- 1) Mason DLFL.
- 2) Amber Booth.

3. Flex Connector Type FC-2:

- a. Neoprene connector single-sphere design for installation in a section of straight pipe.
- b. Design shall be to allow relative movement between the flanges as follows:

<u>Pipe Size</u>	<u>Axial Compression</u>	<u>Axial Elongation</u>
Less than 2 inches	0.375 inch	0.250 inch
2.5 inches	0.500 inch	0.250 inch
3 inches	0.625 inch	0.250 inch
4 inches	0.750 inch	0.375 inch
5 inches - 6 inches	0.875 inch	0.375 inch
over 7 inches	1.000 inch	0.625 inch

- c. Recommended maximum operating pressure shall be at least 150 psi at temperatures below 220 deg F.
 - d. Manufacturer:
- 1) Mason MFEJ.
 - 2) Amber Booth.

E. Felt and Neoprene Pipe Collars:

1. Cushion Sleeve C-1:

- a. A felt or neoprene pad of minimum 1/4-inch thickness which has been treated to resist moisture, abrasion, and temperature and to repel vermin which can be used in conjunction with hangers, pipe clamps and rolls to act as a noise and vibration isolator between piping and its supporting or suspension system.
 - b. Sleeve shall be split or hinged and shall possess an exterior metal shell to prevent crushing during installation.
 - c. Manufacturer:
- 1) Stoneman Trisolator.

2. Pipe Penetrations C-2:
 - a. Pipe to wall or floor closures shall be modular, interlocking synthetic rubber seals shaped to continuously fill the annular space between the pipe and the wall or floor opening.
 - b. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.
 - c. Tightening the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and the wall or floor opening.
 - d. Manufacturer:
 - 1) Link-Seal, manufactured by Thunderline Co.
 - 2) Advanced Products & Systems, Innerlynx.
3. Pipe Penetrations C-3:
 - a. Pipe to wall or floor closures shall be mechanical, interlocking rubber links working as a fire stop to continuously fill the annular space between the pipe and the wall or floor opening.
 - b. Provide UL-listed intumescent formulation with up to a 2-hour fire protection rating.
 - c. Links shall be loosely assembled with bolts to form a continuous rubber link around the pipe.
 - d. Tightening the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight, fireproof seal between the pipe and the wall or floor opening.
 - e. Manufacturer:
 - 1) Metraflex, MetraSeal.

2.03 SEISMIC RESTRAINTS

- A. Equipment shall be fitted for the seismic control per the IBC Seismic Site Class Definition of the project site. This facility is considered an essential facility.
- B. Seismic Restraint Type SR-1:
 1. Snubbers consisting of interlocking steel members (one attached to the equipment frame and the other attached to the building structure) restrained by neoprene rubber compounded to bridge bearing specifications.
 2. Neoprene elements shall be replaceable and have minimum thickness of 3/4 inch at all points.
 3. Restraints shall be installed with factory-set clearances of 1/8 inch minimum to 1/4 inch maximum between steel and neoprene elements.
 4. Snubbers shall be installed after the full equipment load is placed on the vibration isolators to ensure that the equipment will not contact the snubber during normal operation.
 5. Snubbers shall be capable of withstanding loads up to 4g in all directions.
 6. Manufacturer:
 - a. Mason Z1011.
 - b. Amber Booth.

C. Seismic Restraint Type SR-2:

1. Snubbers consisting of interlocking steel members (one attached to equipment frame and the other attached to the building structure) restrained by neoprene rubber compounded to bridge bearing specifications.
2. Neoprene elements shall be replaceable and have minimum thickness of 1/4 inch at all points.
3. Restraints shall be installed with factory set clearances of 1/8 inch minimum to 1/4 inch maximum between steel and neoprene elements.
4. Snubbers shall be installed after the full equipment load is placed on the vibration isolators to ensure that the equipment will not contact the snubber during normal operation.
5. Snubbers shall be capable of withstanding loads up to 1g in all directions.
6. Manufacturer:
 - a. Mason Z1225.
 - b. Amber Booth.

D. Seismic Restraint Type SR-3:

1. Slack cables rigidly attached to suspended equipment or piping.
2. Attachment to structure shall include an interlocking steel element with a minimum 1/4-inch-thick neoprene pad between the interlocking steel members.
3. Cable shall be sized to accommodate dynamic loads up to 1g in all directions without failure.
4. Cables shall have 1/4-inch slack during normal operation of equipment and shall not compromise the efficiency of the vibration isolation hangers.

E. Seismic Housekeeping Pad Anchor, Type PA-1:

1. Seismic housekeeping pad anchors shall be installed on all housekeeping pads. Manufacturer shall size and select pad anchors and calculations shall be submitted and stamped by a registered professional civil or structural engineer.
2. Manufacturer:
 - a. Mason HPA.
 - b. Amber Booth.

2.04 DUCT ATTENUATORS

A. Manufacturers:

1. IAC.
2. Dynasonic.
3. VAW Systems.

B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Tubular Configuration: inner casing and liner, splitters with radius nose and contoured tails, diameter and length as indicated on drawings.

- D. Rectangular Configuration: lined splitters with radius nose and contoured tails, modular, size as indicated on drawings.
- E. Materials:
 - 1. Outer Casing: Minimum 22 gage thick galvanized steel stiffened with mastic filled lock formed seams, 2 inches long, 11 gage slip joints on both ends.
 - 2. Inner Casing and Splitters: Minimum 24 gage thick perforated galvanized steel.
 - 3. Fill: Glass fiber or mineral wool of minimum 4 lb/cu ft density.
 - 4. Fill Liner: 1 mil Mylar film.

2.05 DUCTWORK LAGGING

- A. Acoustic Insulation: 2 inches thick, 3 to 5 lb/cu ft density glass fiber or mineral wool insulation.
- B. Covering: Plaster with surface weight minimum 4 lb/sq ft.

PART 3 - EXECUTION

3.01 RUSTPROOFING

- A. All vibration isolation hardware shall be designed or treated for corrosion resistance.
- B. Isolators exposed to the weather shall have steel parts zinc electroplated, PVC coated, plus a coating of neoprene or bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.
- C. Nuts, bolts, and washers shall be zinc electroplated.
- D. Structural steel bases are to be thoroughly cleaned of welding slag, primed with zinc chromate, and finished with two coats of industrial enamel.

3.02 INSTALLATION

- A. Vibration Isolators: All mechanical equipment, ductwork and piping (except fire, cast iron waste, vent, and storm drains) shall be isolated from the building structure as specified herein and tabulated in the vibration isolation schedule. No motor-driven or circulating-fluid piping shall contact the building without isolation. All isolators shall be secured to the building structure unless specifically called for in the vibration isolation specifications and schedule. Provide a balanced set of isolators for each piece of equipment. Select isolators in accordance with equipment weight distribution to allow for no less than the static deflection specified. All isolators for a single piece of equipment shall have approximately equal spring deflection. A minimum of four isolators per unit is required unless otherwise indicated. The isolator adjusting bolt must be mounted vertically in the center of the spring. Housing must have a rubber grommet in the top allowing a minimum of 1/4 inch between the grommet and the adjustable bolt. Use the type of isolator mounting base and seismic restraints that is indicated in the vibration isolation schedule. Equipment must be mounted absolutely level. Each isolator must be numbered and color-coded to show location. Code and color shall be marked on the plans, on

each equipment isolator, and on each base to ensure proper placement. All isolators shall be clearly stamped or marked to show undeflected height and static deflection so that after the installation and adjustment, deflection under load may be verified to ensure loading is within specified range and isolation is being attained.

- B. Piping: All piping carrying circulating fluids or pumped gases shall be isolated from the building structure with vibration isolators as specified in the vibration isolation schedule. Piping shall not penetrate floating floors or vibration isolated ceilings unless specifically called for in the drawings. Use Type C-2 or C-3 isolators for all piping that passes through the mechanical room floor, walls, or ceiling. The inside diameter of each wall or floor opening shall be sized as recommended by the manufacturer to fit the pipe, isolator and assure a watertight joint. A flexible neoprene connector type FC-1 or FC-2 is required at the inlet and discharge of all floor supported pumps. Flexible neoprene connections are also required at the connections to the chillers and cooling towers. Horizontally suspended piping shall be suspended from massive structural beams rather than slab diaphragms wherever possible. Do not support vibration isolated piping along with non-isolated piping on a common trapeze. Steel spring hanger boxes shall be rigidly mounted to the supporting structure--not located in the middle of the hanger rod. Rigid pipe anchors are not permitted in vibration isolated piping circuits. When pipe anchors are required, use Type E-5. Use Type SH hangers at top of pipe riser for vertical pipe risers greater than 30 feet in height. Unless otherwise indicated on drawings, support and anchor with Type E-5 pipe clamps only at mid-level. Provide Type E-5 guides at other levels. Seismic restraints for vibration isolated piping shall be designed to restrict excessive lateral, vertical, and longitudinal motion without providing support of the piping during normal operation. These restraints shall not make rigid contact between piping and the building structure. Details of the seismic restraints must be included in the submittals. Design shall be approved and stamped by a registered civil or structural engineer.
- C. Ductwork: Ductwork shall be constructed in accordance with applicable SMACNA standards. Flexible connections shall be provided between all fans and connecting ductwork. Support the duct just prior to or following the flexible connector to ensure proper alignment and to avoid binding the connector. Isolate duct penetrations of the floor, walls, and ceiling of all mechanical rooms as follows:
1. The hole in the floor, wall, or ceiling should be oversized so as to allow a 0.5- to 0.75-inch gap on each side of the duct. An 18 gauge sheet metal sleeve covering the entire perimeter of the hole should be plastered to the wall, ceiling, or floor to ensure an air-tight seal. If the duct penetrates a double wall, separate sleeves should be used on each side of the wall so as to have no direct connection between the walls.
 2. The gap between the penetrating duct and sleeve should be packed with fiber insulation and sealed on both outer sides with a resilient acoustical sealant. Provide fire-rated insulation and sealants when penetrating rated walls or floors.
- D. Support duct attenuators independent of ductwork.
- E. Install cross-talk silencers in wall. Caulk wall penetrations.
- F. Lag ductwork, where indicated by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork.
- G. Attach ductwork to acoustic louvers with flexible duct connections.
- H. Install isolation for motor driven equipment.

- I. Bases: Set steel bases for 1 inch of clearance between housekeeping pad and base.
- J. Adjust equipment level.
- K. Install spring hangers without binding.
- L. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- M. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- N. Provide pairs of horizontal limit springs on fans with more than 6.0-inch static pressure, and on hanger-supported, horizontally mounted axial fans.
- O. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05-inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.
- P. Support piping connections to isolated equipment resiliently as follows:
 - 1. Up to 4-Inch Diameter: First three points of support.
 - 2. 5 to 8-Inch Diameter: First four points of support.
 - 3. 10-Inch Diameter and Over: First six points of support.
 - 4. Select three hangers closest to vibration source for minimum 1.0-inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0-inch static deflection or 1/2 the static deflection of isolated equipment.

3.03 FIELD QUALITY CONTROL

- A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.04 SCHEDULES

A. PIPE ISOLATION SCHEDULE

Pipe Size (Inches)	Minimum Isolated Distance from Equipment
1	120 diameters
2	90 diameters
3	80 diameters
4	75 diameters
6	60 diameters
8	60 diameters
10	54 diameters
12	50 diameters
16	45 diameters
24	38 diameters

B. EQUIPMENT ISOLATION SCHEDULE

Equipment	Note	R.P.M.	ON GRADE MIN				ABOVE GRADE MIN			
			Base	Isolator	Static Defn (Ins)	Seismic Restr't	Base	Isolator	Static Defn (Ins)	Seismic Restr't
Ducts	(1)	-	-	-	-	-	-	E-3	-	SR-3
Fans (floor mounted and internally spring isolated)	(2)	500-750	-	-	-	-	SB-1	S-1	3.0	SR-1
	(3)	751-1000	-	-	-	-	SB-1	S-1	2.5	SR-1
		1001-1200	-	-	-	-	SB-1	S-1	1.5	SR-1
		Above 1200	-	-	-	-	SB-1	S-1	1.0	SR-1
Piping (Supported)	(4)	Over 2 inch dia	-	S-2	1.0	SR-2	MB-1	S-2	1.0	SR-2
	(5)	uninsulated 2 inch dia & less	-	C-1	0.1	-	-	C-1	0.1	-
Piping (Suspended)	(4)	Over 2 inch dia 2 inch dia & less	Not Applicable				-	SH-2	1.0	SR-3
							-	C-1	0.1	-
Unit Heaters		All	-	-	-	-	-	SH-1	1.0	SR-3
Pumps	(6)						IB-1	S-1	1.0	SR-1

Notes:

1. All ductwork within the mechanical room and extending for a distance no less than 40 feet from the vibration isolated equipment shall be isolated with a static deflection of 0.75 inches. If additional isolators are required, use isolators with a static deflection no less than 0.25 inches.
2. Fans with speeds less than 700 RPM are not recommended for installation above grade.
3. Thrust restraints type TR-1 must be installed on fans developing a total static pressure of 2 inches and above and on fans whose isolator deflections exceeds 2 inches.
4. Piping shall be supported or suspended on steel spring isolators in the mechanical equipment room and for a distance of 40 feet from a pump or spring isolated equipment. In other cases, support or suspension shall have a neoprene or felt pad element between the pipe and its attachment to the structure.
5. Piping connected to pumps shall be connected with pipe FC-1 or FC-2 flexible connectors.
6. Pumps over 5 hp located above grade shall be mounted on inertia bases as indicated.

END OF SECTION

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