

## SECTION 15241 - VIBRATION AND SEISMIC CONTROL

## PART 1 - GENERAL

## 1.1 DESCRIPTION OF WORK:

- A. Extent of vibration control work required by this section is indicated on drawings and schedules, and/or specified in other Division-15 sections.
1. All mechanical equipment, piping and ductwork as noted or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
  2. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
  3. All such systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.
  4. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements.)
  5. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.
  6. Seismic restraints shall be designed in accordance with seismic force levels as detailed in Section 1.7.
- B. The work in this section includes, but is not limited to the following:
1. Vibration isolation for piping, ductwork and equipment.
  2. Equipment isolation bases.
  3. Flexible piping connections.
  4. Seismic restraints for isolated equipment.
  5. Seismic restraints for non-isolated equipment.
  6. Certification of seismic restraint designs and installation supervision.
  7. Certification of seismic attachment of housekeeping pads.
  8. All mechanical and electrical systems (installed by Division 15, e.g., Temperature Controls). Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical. (Equipment not listed is still included in this specification).

AC Units	Cooling Towers
Air Distrib.Boxes	Ductwork
Air Handling Units	Control Panels
Air Separators	Fans (All types)
Boilers	Heat Exchangers
Cabinet Heaters	Piping
Cable Trays	Pumps (All types)
Chillers	Rooftop Units

Compressors	Tanks (All types)
Comp. Room Units	Unit Heaters
Condensers	Conduit
Condensing Units	Water Heaters
	Var. Freq. Drives (including isolation transformers)

9. Fire protection systems are excluded from this section; see under separate fire protection sections.
- C. Vibration control products furnished as integral part of factory-fabricated equipment shall comply with the requirements of this section.
- D. For additional and supplemental requirements, refer to other Division 15 sections for equipment foundations; hangers; sealants; gaskets; requirements of electrical connections to equipment isolated on vibration control products; requirements of duct connections to air handling equipment isolated on vibration control products.
- E. Definitions
  1. Life Safety Systems:
    - a. All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust systems. See separate section(s) for fire protection requirements.
    - b. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flowpaths to fire protection and/or emergency lighting systems.
    - c. All medical and life support systems.
    - d. Fresh air relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.
    - e. All life safety equipment has an asterisk on the equipment schedule.
  2. Positive Attachment:
    - a. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, or any other equipment are not acceptable on this project as seismic anchor points.
  3. Transverse Bracing:
    - a. Restraint(s) applied to limit motion perpendicular to the center line of the pipe, duct or conduit.
  4. Longitudinal Bracing:
    - a. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

## 1.2 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration and seismic control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
1. Except as otherwise indicated, vibration and seismic control products shall be obtained from single manufacturer and shall be certified by the manufacturer.
  2. Engage manufacturer to provide technical supervision of installation of support isolation and seismic units produced, and of associated inertia bases (if any).

## 1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of vibration and seismic control product. Submit schedule showing size, type, deflection, and location for each product furnished.
1. Include data for each type and size of unit, showing specific restraints, isolation efficiency, stiffness, natural frequency and transmissibility at lowest operating speed of equipment detailing compliance with the specification.
  2. For spring units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics, ratio of horizontal to vertical stiffness and bases of spring-rated selection for range of loading weights.
  3. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
  4. Include performance certifications from manufacturers.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components. Detail bases, and show location of equipment anchoring points and seismic restraints coordinated with equipment manufacturer's shop drawings.
1. Shop drawings showing structural design and details of inertia bases, steel beam bases and other custom-fabricated work not covered by manufacturer's submitted data.
    - a. Furnish templates, anchor bolts and sleeve for equipment bases, seismic restraints, foundations and other support systems for coordination of vibration isolation and seismic control units with other work.
    - b. Provide all details of suspension and support for ceiling hung equipment.
    - c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Submittals shall include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

- d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
    - 2. Submit shop drawings indicating scope of vibration isolation work and locations of units and flexible connections. Include support isolation points for piping and ductwork including risers and inertia bases.
      - a. Include schedule of units, showing size or manufacturer's part number, and weight supported and resulting deflection of each unit.
  - C. Maintenance Data: Submit maintenance data for each type of vibration and seismic control product. Include this data, product data and shop drawings in maintenance manual; in accordance with requirements of Divisions 15.
  - D. Seismic Certification and Analysis:
    - 1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
    - 2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode.
    - 3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and-or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in Section 1.7 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.
- 1.4 CODE AND STANDARDS REQUIREMENTS:
- A. Applicable Codes and Standards
    - 1. The Uniform Building Code (UBC) as published by the International Conference of Building Officials.
    - 2. All State and Local Codes.
    - 3. ASHRAE HVAC Applications Handbook Sound and Vibration Control.
    - 4. SMACNA Seismic Restraint Manual Guidelines For Mechanical Systems.
- 1.5 MANUFACTURER'S RESPONSIBILITY:
- A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:
    - 1. Determine vibration isolation and seismic restraint sizes and locations.
    - 2. Provide vibration isolation and seismic restraints as scheduled or specified.
    - 3. Provide calculations and materials if required for restraint of unisolated equipment.

- 4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.6 RELATED WORK:

A. Housekeeping Pads

- 1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
- 2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel

- 1. Contractor shall supply supplementary support steel for al equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

C. Attachments

- 1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.7 SEISMIC FORCE LEVELS:

Edit Note: Edit the following table for each project, select appropriate seismic zone. Verify values with applicable code. See Mason Seismic Catalog for BOCCA or SBCCI codes; a different table is required. See Chapter 16, Vol. 2 of UBC for additional background information.

- A. The following force levels will be used on this project based on UBC-94.

MINIMUM "G" FORCES EQUAL TO OR EXCEEDING BUILDING CODE LISTED ABOVE

"G" Forces for All Pipe, Duct & Conduit		"G" Forces for Rigidly Mounted Equipment		"G" Forces for Flexibly Mounted Equipment		"G" Forces for Life Safety Equipment either Rigidly or Flexibly Mounted	
Horiz	Vert	Horiz	Vert.	Horiz	Vert.	Horiz	Vert
N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R
0.06	0.02	0.06	0.02	0.1	0.03	0.25	0.07

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products by:
1. Vibration and Seismic Control Products:
    - a. Mason Industries, Inc.
- B. Alternate Manufacturer: All vibration isolators and seismic restraints described in this section shall be the product of a single manufacturer. Mason Industry's products are the basis of these specifications; products of other manufacturers are acceptable provided their systems strictly comply with the specification and have been reviewed by the Engineer. Submittals and certification sheets shall be in accordance with Section 1.3.
- C. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8 inch and/or horizontal permanent deformation greater than 1/4 inch.

## 2.2 PRODUCT DESCRIPTIONS:

- A. Vibration Isolators and Seismic Restraints

<p>Edit Note: Do NOT remove specification types when editing specifications.</p>
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The following product descriptions are listed by a number which is used as the identifier for the vibration isolation and seismic control schedule.

1. Two layers of ¾ inch thick neoprene pad consisting of 2 inches square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
2. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2 inches and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Preapproval "R: Number from OSHPD verifying the maximum certified horizontal and vertical load ratings. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross

members where applicable. All neoprene shall be bridge bearing quality. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.

4. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or ¼ inch neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
6. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of ½ inch shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings. Mountings shall be SLR as manufactured by Mason Industries, Inc.
7. Not Used
8. Not Used
9. Not Used
10. Hangers shall consist of rigid steel frames containing minimum 1-1/4 inches thick neoprene elements at the top and a steel spring with general characteristics as in Specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degrees capability. Hangers shall be Type 30N as manufactured by Mason Industries, Inc.
11. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30 degrees capability. Hangers shall be Type PC30N as manufactured by Mason Industries, Inc.
12. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to

final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.

13. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "R" Number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be Type SSB as manufactured by Mason Industries, Inc.

Note: Specifications 12-14 apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.

14. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
15. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD. Clevis cross brace shall be Type CCB as manufactured by Mason Industries, Inc.
16. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of ¼ inch thick. Rated loadings shall not exceed 1000 psi. A minimum air gap of 1/8 inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Preapproval "R" Number from OSHPD verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1225 as manufactured by Mason Industries, Inc.
17. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specification. Elastomeric materials shall be replaceable and a minimum of ¾ inch thick. Rated loadings shall not exceed 1000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch nor more than ¼ inch. Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8 inch deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to ½ inch deflection in the x, y and z planes. Snubbers shall have an anchorage preapproval "R" Number from OSHPD verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be series Z-1011 as manufactured by Mason Industries, Inc.

18. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O. Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be Type SAS as manufactured by Mason Industries, Inc.
19. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O. Evaluation Service, Inc. verifying its allowable loads. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.
20. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1 inch. Bases shall be Type WF as manufactured by Mason Industries, Inc.
21. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbow. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6 inches. The base depth need not exceed 12 inches unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of ½ inch bars welded in place on 6 inches centers running both ways in a layer 1-1/2 inch above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1 inch clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable. Base shall be Type BMK or K as manufactured by Mason Industries, Inc.
22. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushing shall be a minimum of ¼ inch thick. Steel springs shall be laterally stable and rest on ¼ inch thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2 inches of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit must be solidly fastened to the top floating rail, and the lower Z section anchored to the roof structure. Curb shall have anchorage preapproval "R" from OSHPD attesting to the maximum certified horizontal and vertical load rating. Curb shall be Type RSC as manufactured by Mason Industries, Inc.

23. Flexible spherical expansion joints shall employ peroxide cured U.V. resistant EPDM in the covers, liners and Dacron tire cord frictioning. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2 inches and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16inches to 24inches may be single sphere. Sizes ¾ inch to 1-1/2 inches may have threaded bolted flange assemblies, one sphere and cable retention. 14inches and smaller connectors shall be rated at 250 psi up to 190 degrees F with a uniform drop in allowable pressure to 190 psi at 250 degrees F. 16 inches and larger connectors are rated 180 psi at 190 degrees F and 135 psi at 250 degrees F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints.

Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods shall be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have ½ inch thick neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves.

Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.

24. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3 inch and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

	Flanged		Male Nipples	
3 x 14	10 x 26	1/2 x 9	1-1/2 x 13	
4 x 15	12 x 28	3/4 x 10	2 x 14	
5 x 19	14 x 30	1 x 11	2-1/2 x 18	
6 x 20	16 x 32	1-1/4 x 12		
8 x 22				

Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be Type BSS as manufactured by Mason Industries, Inc.

25. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum ½ inch thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable

loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be Type ADA as manufactured by Mason Industries, Inc.

26. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum  $\frac{1}{2}$  inch thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of  $\pm 1\text{-}5/8$  inch motion, or to meet location requirements. Pipe guides shall be Type VSG as manufactured by Mason Industries, Inc.
27. Split Wall Seals consist of two bolted pipe halves with minimum  $\frac{3}{4}$  inch thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1 inch past either face of the wall. Where temperatures exceed 240 degrees F, 10# density fiberglass may be used in lieu of the sponge. Seals shall be Type SWS as manufactured by Mason Industries, Inc.
28. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in Specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of  $\frac{1}{4}$  inch movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the duct work or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be Type WBI/WBD as manufactured by Mason Industries, Inc.

### PART 3 - EXECUTION

#### 3.1 INSPECTION:

- A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

#### 3.2 PERFORMANCE OF ISOLATORS:

- A. General: Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units to achieve minimum static deflection and displacement requirements.

#### 3.3 APPLICATIONS:

- A. General: Except as otherwise indicated, select vibration control products in accordance with ASHRAE Handbook, 1995 HVAC Applications Volume, Chapter 43 "Sound and Vibration Control", Table 42 Chapter 40 for Seismic Restraint Design.

#### 3.4 GENERAL:

- A. Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.
- B. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- C. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- E. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- F. Coordinate work with other trades to avoid rigid contact with the building.
- G. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architect's/engineer's attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- H. Bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- I. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.
- J. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
  - 1. Flanges of structural beams.
  - 2. Upper truss cords in bar joist construction.
  - 3. Cast in place inserts or wedge type drill-in concrete anchors.
- K. Specification 12 cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, piping or conduit.
- L. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.
- M. At locations where Specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with Specification 14 braces.
- N. At all locations where Specification 12 or 13 restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification type 15 braces.

- O. Drill-in concrete anchors for ceiling and wall installation shall be Specification Type 18, and Specification Type 19 female wedge type for floor mounted equipment.
  - P. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.
  - Q. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces.
  - R. Hand built elastomeric expansion joints maybe used when pipe sizes exceed 24inches or specified movements exceed Specification 23 capabilities.
  - S. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide Specification 27 wall seals.
  - T. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be Specification Type 28.
  - U. Locate isolation hangers as near to the overhead support structure as possible.
  - V. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
  - W. Install inertia base frames on isolator units so that minimum of 1inch clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation.
  - X. For air handling equipment, install thrust restraints as indicated, and also wherever thrust exceeds 10 percent of equipment weight.
  - Y. Weld riser isolator units in place as required to prevent displacement from loading and operations.
  - Z. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.
- 3.5 VIBRATION ISOLATION OF PIPING:
- A. Seismic Restraint of Piping
    - 1. Seismically restrain all piping listed as a, b or c below. Use Specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
      - a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1 inch I.D. or larger.
      - b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1-1/4 inch I.D. and larger.
      - c. All other piping 2-1/2 inch diameter and larger.
    - 2. Transverse piping restraints shall be at 40 feet maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

3. Longitudinal restraints shall be 80 feet maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
5. For fuel oil and all gas piping transverse restraints shall be at 20 feet maximum and longitudinal restraints at 40 feet maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24 inches of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.
9. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly shall be braced in accordance with seismic product manufacturer's recommendations and SMACNA Seismic Restraint Manual Guidelines For Mechanical Systems.

B. Seismic restraint of duct work

1. Seismically restrain all duct work with Specification 12 or 13 restraints as listed below:
  - a. Restrain rectangular ducts with cross sectional area of 6 sq. feet or larger.
  - b. Restrain round ducts with diameters of 28 inches or larger.
  - c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
2. Transverse restraints shall occur at 30 foot intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
3. Longitudinal restraints shall occur at 60 foot intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4 feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
4. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
5. A group of ducts may be combined in a larger frame so that the combined weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non-bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

- C. Seismic Restraint of Electrical Services (Applicable To All Division 15 Electrical Wiring Requirements):
1. All electrical conduit 2-1/2 feet in diameter and larger shall be restrained with Specification Type 12 seismic cable restraints or Specification 13 for seismic solid brace restraints.
  2. All electrical bus ducts, cable trays and ladder trays shall be restrained with Specification Type 12, seismic cable restraints or Specification 13 seismic solid brace restraints.
  3. Transverse restraints shall occur at 30 foot intervals or both ends if the electrical run is less than the specified interval. Transverse restraints shall be installed at each electrical services turn and at each end of the electric run.
  4. Longitudinal restraints shall occur at 60 foot intervals with at least one restraint per electric run. Transverse restraints for one electric section may also act as a longitudinal restraint for a duct for an electric section connected perpendicular to it if the restraints are installed within 4' of the intersection of the electric run and if the restraints are sized for the larger electric run.
  5. All rigid floor mounted equipment must have a resilient media between the equipment mounting hole and the anchor bolt. Anchor bolts shall be designed in accordance with Section 1.06 seismic forces. Neoprene bushings shall be Specification Type 4 and anchor bolts shall be Specification Type 18 or 19.
- D. All mechanical equipment shall be vibration isolated and seismically restrained as per the schedules in Part 4 of this specification.
- 3.6 SEISMIC RESTRAINT EXCLUSIONS:
- A. Piping
1. All piping less than 2-1/2 Inches in diameter except those listed below.
  2. All gas piping, fuel oil piping and medical gas piping less than 1 inch I.D.
  3. All piping in boiler and mechanical equipment rooms less than 1-1/4 inch I.D.
  4. All clevis or trapeze supported piping suspended from hanger rods where the point of attachment is less than the 12 inches in length from the structure to the structural connection of the clevis or trapeze.
  5. All PVC and fiberglass suspended waste or vent pipe 6 inches in diameter and smaller.
- B. Duct Work
1. Rectangular, square or oval ducts less than 6 sq. feet in cross sectional area.
  2. Round duct less than 28 inches in diameter.
  3. Duct supported by hanger rods where the point of attachment is less than 12 inches in length from the structure to the structural connection of the duct work.
- C. Electrical
1. All conduit less than 2-1/2 inches in diameter suspended by individual hanger rods.

- 2. All clevis or trapeze supported conduits suspended by hanger rods where the point of attachment is less than 12 inches in length from the structure to the structural connection of the clevis or trapeze.

D. Suspended Equipment

- 1. VAV boxes and fan powered equipment weighing less than 50 lbs. and rigidly connected to the supply side of the duct system and supported with a minimum of 4 hanger rods.

3.7 EXAMINATION OF RELATED WORK:

A. Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish written report to Engineer listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:

- 1. Equipment installations (performed as work of other sections) on vibration isolators.
- 2. Piping connections including flexible connections.
- 3. Ductwork connections including provisions for flexible connections.
- 4. Passage of piping and ductwork which is to be isolated through walls and floors.

B. Do not start-up equipment until inadequacies have been corrected.

3.8 ADJUSTING AND CLEANING:

A. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.9 DEFLECTION MEASUREMENTS:

A. Upon completion of vibration isolation work, prepare report showing measured equipment deflections theoretical floor deflection and isolation efficiency for each major item of equipment.

PART 4 - SCHEDULES

4.1 EQUIPMENT ISOLATOR AND SEISMIC RESTRAINT SCHEDULE:

EQUIPMENT SCHEDULE	VIBRATION ISOLATION AND/OR SEISMIC RESTRAINT	
	SPECIFICATION	STATIC DEFLECTION

