SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION

A. Intent:
   1. All equipment, piping, ductwork and electrical distribution as noted on the equipment schedule or in the specification shall be mounted using 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. All isolators and isolation materials for the Project shall be of the same manufacturer and shall be certified by the manufacturer.
   3. It is the intent of the seismic portion of this specification to keep all life-safety, plumbing, mechanical and electrical building system components in place during a seismic event.
   4. All such systems shall be installed in strict accordance with seismic codes, component manufacturer's requirements and building construction standards. Whenever a conflict occurs between the manufacturer's requirements or construction standards, the most stringent shall apply.
   5. 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).
   6. Any variance or non-compliance with these specification requirements shall be corrected in an Architect Engineer approved manner and without additional expense to the Owner.
   7. Seismic restraints shall be designed in accordance with seismic design criteria as indicated on drawings and ASCE 7 chapter 13.

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 life-safety, plumbing, mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included.

1.03 RELATED SECTIONS

A. Section 21 05 48 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.

B. Section 22 05 48 - Plumbing Vibration Isolation And Seismic Restraint.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems: Vibration isolation and seismic restraint.

1.04 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.

C. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment; 2002.

D. FEMA 413 - Installing Seismic Restraints for Electrical Equipment; 2004.

E. FEMA 414 - Installing Seismic Restraints for Duct and Pipe; 2004.

F. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage; 2012.

G. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 CODE AND STANDARDS REQUIREMENTS

A. Applicable codes and standards are referenced on the drawings.

B. ASCE 7, Chapter 13.

1.07 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.

1.08 RELATED WORK

A. Housekeeping Pads:
   1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the supplier of restraints, if not already indicated on the drawings.
   2. Housekeeping pads shall be coordinated with the supplier of restraints 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: Provide supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

C. Attachments: Provide 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.

PART 2 PRODUCTS

2.01 INTENT

A. All vibration isolators and seismic restraints described in this section shall be the product of a single manufacturer.
   1. Mason Industries, www.mason-ind.com, products are the basis of these specifications; products of other manufacturers are acceptable provided their systems strictly comply with the specification and have the approval of the Architect Engineer.
   2. Substitutions: See Section 01 60 00 - Product Requirements.
   3. Submittals and certification sheets shall be in accordance with paragraph Submittals.
   4. 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 (3 mm) and/or horizontal permanent deformation greater that 1/4 inch (6 mm).

2.02 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraints:

1. Type 1: Two layers of 3/4 inch (19 mm) thick neoprene pad consisting of 2 inches (50 mm) square waffle modules separated horizontally by a 1/16 inch (1.5 mm) gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be equal to type Super W as manufactured by Mason Industries, Inc.
2. Type 2: Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2 inch (5 mm) 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 be UL listed for seismic restraint. Mountings shall be equal to type BR as manufactured by Mason Industries, Inc.
3. Type 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 equal to type PB as manufactured by Mason Industries, Inc.
4. Type 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 equal to type HG as manufactured by Mason Industries, Inc.
5. Type 5: Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4 inch (6 mm) neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that shall be rigidly bolted to the equipment. Spring diameters shall be no less than 80% of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be equal to type SLF as manufactured by Mason Industries, Inc.
6. Type 6: Restrained spring mountings shall have an SLF mounting as described in Type 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. Installed and operating heights are equal. A minimum clearance of 1/2 inch (12 mm) shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Restraining Bolts shall have a neoprene bushing between the bolt and the housing. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there shall be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall be UL listed for seismic restraint. Mountings shall be equal to type SLR or SLRS as manufactured by Mason Industries, Inc.
7. Type 7: Spring mountings as in Type 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4 inch (6 mm) travel in all directions before contacting the resilient snubbing collars. Mountings shall be UL listed for seismic restraint. Mountings shall be equal to type SSLFH as manufactured by Mason Industries, Inc.
8. Type 8: Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8 inch (3 mm). Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician. Air Springs shall

be equal to type MT and leveling valves equal to type LV as manufactured by Mason Industries, Inc.

9. Type 9: Restrained air spring mountings shall have an MT air spring as described in Type 8, within a rigid housing that includes vertical limit stops to prevent air 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 1/2 inch (12 mm) shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces. Mountings shall be equal to type SLR-MT as manufactured by Mason Industries, Inc.
10. Type 10: Hangers shall consist of rigid steel frames containing minimum 1-1/4 inch (32 mm) thick neoprene elements at the top and a steel spring with general characteristics as in Type 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-degree arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30-degree capability. Hangers shall be equal to type 30N as manufactured by Mason Industries, Inc.
    a. Type 10A: Hangers shall be as described in Type 10, but they shall be supplied with a combination rubber and steel rebound washer as the seismic upstop for suspended piping, ductwork, equipment and electrical cable trays. Rubber thickness shall be a minimum of 1/4 inch (6 mm). Submittals shall include a drawing of the hanger showing the installation of the rebound washer. Hangers shall be equal to type RW30N as manufactured by Mason Industries, Inc.
11. Type 11: Hangers shall be as described in Type 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-degree capability. Hangers shall be equal to type PC30N as manufactured by Mason Industries, Inc.
12. Type 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. Cables shall be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables shall not be allowed to bend across sharp edges. Cable assemblies shall be UL listed for seismic restraint. At trapeze anchor locations piping shall be shackled to the trapeze. Cable assemblies shall be equal to type SCB at the ceiling and at the clevis bolt, equal to SCBH between the hanger rod nut and the clevis or equal to SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.
13. Type 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 OPA number from OSHPD in the state of California verifying the maximum certified load ratings. At trapeze anchor locations piping shall be shackled to the trapeze. Solid seismic brace assemblies shall be equal to type SSB, SSBS or SSRF as manufactured by Mason Industries, Inc.
14. Type 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 OPA Number from OSHPD in the State of California. At trapeze anchor locations piping shall be shackled to the trapeze. Rod clamp assemblies shall be equal to type SRC or UC as manufactured by Mason Industries, Inc.

15. Type 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 be UL listed for seismic restraint. Clevis cross brace shall be equal to type CCB as manufactured by Mason Industries, Inc.
16. Type 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 1/4 inch (6 mm) thick. Rated loadings shall not exceed 1000 psi (70.3 kg/sq-cm). A minimum air gap of 1/8 inch (3 mm) 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 be UL listed for seismic restraint. Snubber shall be equal to type Z-1225 as manufactured by Mason Industries, Inc.
17. Type 17: All-directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4 inch (19 mm) thick. Rated loadings shall not exceed 1000 psi (70.3kg/sq-cm). Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch (3 mm) nor more that 1/4 inch (6 mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8 inch (9 mm) 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 1/2 inch (12 mm) deflection in the x, y and z planes. Snubbers shall have an anchorage preapproval OPA number from OSHPD in the state of California verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be equal to type Z-1011 as manufactured by Mason Industries, Inc.
18. Type 18: Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is rolled 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 ICC Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be equal to type SAS as manufactured by Mason Industries, Inc.
19. Type 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 ICC Evaluation Service, Inc. verifying to its allowable loads. Drill-in female wedge anchors shall be equal to type SAB as manufactured by Mason Industries, Inc.
20. Type 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 (350 mm) provided that deflection and misalignment are limited to values that are acceptable to the . Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1 inch (25 mm). Bases shall be equal to type WF as manufactured by Mason Industries, Inc.
21. Type 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 elbows. Base depth shall be a minimum of 1/12 of the longest dimension of the base but not less than 6 inches (150 mm). The base depth need not exceed 12 inches (300 mm) unless specifically recommended by the base

manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2 inch (12 mm) bars welded in place on 6 inches (150 mm) centers running both ways in a layer 1-1/2 inches (38 mm) 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 (25 mm) clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable. Base shall be equal to type BMK or K as manufactured by Mason Industries, Inc.

22. Type 22: Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal or structural steel sections containing adjustable and removable steel springs that support the upper floating section. The upper frame shall provide continuous support for the equipment and shall be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of 1/4 inch (6 mm) thick. Steel springs shall be laterally stable and rest on 1/4 inch (6 mm) thick neoprene acoustical pads. Hardware shall be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous flexible flashing nailed over the lower curbs waterproofing. All spring locations shall have accessibility to adjust springs. Lower curbs shall have provision for 2 inch (50 mm) of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit shall be solidly fastened to the top floating rail, and the lower section anchored to the roof structure. Curb shall be UL listed for seismic restraint. Curb shall be equal to type SRSC or RMSS as manufactured by Mason Industries, Inc.
23. Type 23: Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar® tire cord frictioning. Any substitutions shall have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2 inches (50 mm) and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches (400 mm) to 24 inches (600 mm) may be single sphere. Sizes 3/4 inch (19 mm) to 1-1/2 inches (38 mm) may have threaded two piece bolted flange assemblies, one sphere and cable retention. Connectors shall be rated at 250 psi (1.72 MPa) up to 170 degrees F (77 degrees C) with a uniform drop in allowable pressure to 215 psi (1.48 MPa) at 250 degrees F (121 degrees C) in sizes through 14 inches (350 mm). 16 inches (400 mm) through 24 inches (600 mm) single sphere minimum ratings are 180 psi (1.24 MPa) at 170 degrees F (77 degrees C) and 150 psi (1.03 MPa) at 250 degrees F (121 degrees C). Higher rated connectors may be used to accommodate service conditions. All expansion joints shall be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3:1. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
    a. 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. If control rods are used, they shall have 1/2 inch (12 mm) thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi (70.3 kg/sq-cm) maximum on the washer area.
    b. 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 actual blade passage frequencies on this project. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be equal to type SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.
24. Type 24: Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3 inches (75 mm) and larger shall be flanged. Smaller sizes shall have male nipples.
    a. Minimum lengths shall be as follows:

1) Flanged:
   (a) 3 inches x 14 inches (75 by 350 mm)
   (b) 4 inches x 15 inches (100 by 375 mm)
   (c) 5 inches x 19 inches (125 by 475 mm)
   (d) 6 inches x 20 inches (150 by 500 mm)
   (e) 8 inches x 22 inches (200 by 550 mm)
   (f) 10 inches x 26 inches (250 by 650 mm)
   (g) 12 inches x 28 inches (300 by 700 mm)
   (h) 14 inches x 30 inches (350 by 750 mm)
   (i) 16 inches x 32 inches (400 by 800 mm)
2) Male Nipples:
   (a) 1/2 inch x 9 inches (12 by 225 mm)
   (b) 3/4 inch x 10 inches (19 by 250 mm)
   (c) 1 inch x 11 inches (25 by 275 mm)
   (d) 1-1/4 inches x 12 inches (32 by 300 mm)
   (e) 1-1/2 inches x 13 inches (38 by 325 mm)
   (f) 2 inches x 14 inches (50 by 350 mm)
   (g) 2-1/2 inches x 18 inches (64 by 450 mm)

b. 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 equal to type BSS as manufactured by Mason Industries, Inc.

25. Type 25: All-directional acoustical pipe anchor shall consist of two sizes of steel tubing separated by a minimum 1/2 inch (12 mm) 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 (35.2 kg/sq-cm) and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be equal to type ADA as manufactured by Mason Industries, Inc.
26. Type 26: Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2 inch (12 mm) 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 plus or minus 1-5/8 inches (41 mm) motion, or to meet location requirements. Pipe guides shall be equal to type VSG as manufactured by Mason Industries, Inc.
27. Type 27: Split Wall Seals consist of two bolted pipe halves with minimum 3/4 inch (19 mm) 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 (25 mm) past either face of the wall. Where temperatures exceed 240 degrees F (115 degrees C), 10 pounds per cubic foot (160 kg/cu. m) density fiberglass may be used in lieu of the sponge. Seals shall be equal to type SWS as manufactured by Mason Industries, Inc.
28. Type 28: The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in Type 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 1/4 inch (6 mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork 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 equal to type WBI/WBD as manufactured by Mason Industries, Inc.
29. Type 29: Housekeeping pad anchors shall consist of a ductile iron casting that is tapered and hexagonal, smaller at its base than at its top. The upper portion shall have holes for

rebar to pass through. The anchor shall be continuously threaded from top to bottom for the attachment of soleplates. Housekeeping pad anchors shall be attached to the structural slab using a stud wedge anchor. Housekeeping pad anchors shall be equal to type HPA and stud wedge anchor shall be equal to type SAS both as manufactured by Mason Industries, Inc.

PART 3 EXECUTION

3.01 GENERAL

A. All vibration isolators and seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

B. Installation of vibration isolators and seismic restraints shall not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. Do 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.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. 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 Engineer's attention prior to installation. Corrective work required by conflicts after installation shall be at no additional cost to the Owner.

G. Bring to the Architect 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 required by discrepancies after installation shall be at no additional cost to the Owner.

H. Correct all installations which are deemed defective in workmanship and materials at no additional cost to the Owner.

I. Overstressing of the building structure shall not occur because of overhead support of equipment. Submit loads to the structural engineer of record for approval. Generally bracing may occur from:
   1. Flanges of structural beams.
   2. Panel points in bar joist construction.
   3. Cast in place inserts or wedge type drill-in concrete anchors.

J. Type 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

K. Type 12 cable assemblies are installed taut on non-isolated systems. Type 13 seismic solid braces may be used in place of cables on rigidly attached systems only.

L. At locations where Type 12 or Type 13 restraints are located, the support rods shall be braced when necessary to accept compressive loads with Type 14 braces.

M. At locations where Type 12 cable restraints are installed on support rods with spring isolators, the spring isolation hangers shall be Type 10A.

N. At all locations where Type 12 or Type13 restraints are attached to pipe clevis's, the clevis cross bolt shall be reinforced with Type 15 braces.

O. Drill-in concrete anchors for ceiling and wall installation shall be Type 18, and 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. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24 inches or specified movements exceed Type 23 capabilities.

R. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide Type 27 wall seals.

S. 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 Type 28.

T. Locate isolation hangers as near to the overhead support structure as possible.

U. All fire protection piping shall be braced in accordance with NFPA 13 and 14.

V. All mechanical equipment shall be vibration isolated and seismically restrained as per the schedules shown on the drawings.

W. All fire protection equipment is considered life safety equipment and shall be seismically restrained using the seismic force levels calculated for life safety equipment according to the codes and standards shown on Structural Drawings.

X. VAV boxes and fan powered equipment weighing less than 50 pounds (23 kg) and rigidly connected to the supply side of the duct system and supported with a minimum of 4 hanger rods.

3.02 VIBRATION ISOLATION OF PIPING

A. Horizontal Pipe Isolation: The first four pipe hangers in the main lines near the mechanical equipment shall be as described in Type 11. Brace hanger rods with SRC clamps Type 14. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in Type 10 & Type 10A. Floor supported piping shall rest on isolators as described in Type 6. Heat exchangers and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75 inch (19 mm) deflection for pipe sizes up to and including 3 inch (75 mm), 1-1/2 inch (38 mm) deflection for pipe sizes up to and including 6 inch (150 mm), and 2-1/2 inch (64 mm) deflection for pipes larger than 6 inch (150 mm) Hangers shall be located as close to the overhead structure as practical. Hanger locations that also have seismic restraints attached shall have type RW Rebound Washers to limit uplift. Where piping connects to mechanical equipment install Type 23 expansion joints or Type 24 stainless hoses as required for the service.

B. Riser Isolation: Risers shall be suspended from Type 10A hangers or supported by Type 5 mountings, anchored with Type 25 anchors, and guided with Type 26 sliding guides. Steel springs shall be a minimum of 0.75 inch (19 mm) except in those expansion locations where additional deflection is required to limit load changes to plus or minus 25 percent of the initial load. 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.

C. Seismic Restraint of Piping:
   1. Seismically restrain all piping listed as a, b or c below. Use Type 12 cables if isolated. Type 12 or Type 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 (25 mm) I.D. or larger.
      b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1-1/4 inch (32 mm) I.D. and larger.
      c. All other piping 2-1/2-inch (64 mm) diameter and larger.

2. Transverse piping restraints shall be at 40 feet (12 m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80 feet (24 m) 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 (6 m) maximum and longitudinal restraints at 40 feet (12 m) 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 (600 m) of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps shall 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 in areas with Ss of 0.35 or greater shall be braced as in Sections 3.02.C.2 and 3.02.C.3. For areas with Ss less than 0.35, 2 band clamps may be used with a reduced spacing of 1/2 of those listed in sections 3.02.C.2 and 3.02.C.3.
10. Connection to the structure shall be made with a non-friction connection (i.e. no C-clamps).
11. Hanger locations that also have seismic restraints attached shall have Type 10A RW Rebound Washers.

D. Pipe Exclusions:
1. Gas piping less than 1 inch (25 mm) inside diameter.
2. Piping in boiler and mechanical rooms less than 1-1/4 inch (32 mm) inside diameter.
3. All other piping less than 2-1/2 inch (64 mm) inside diameter.
4. Certain suspended piping:
   a. All piping suspended by clevis hangers where the distance from the top of the pipe to the suspension point is 12 inches or less.
   b. All trapeze supported piping where the distance from the suspension point to the trapeze member is 12-inch or less.
   c. If any suspension location in the run fails to qualify under (a) or (b) above, the entire run shall be braced.

3.03 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF DUCTWORK

A. Vibration isolation of ductwork:
1. All discharge runs for a distance of 50 feet (15m) from the connected equipment shall be isolated from the building structure by means of Type 10 hangers or Type 5 floor isolators. Spring deflection shall be a minimum of 0.75 inch (19 mm).
2. All duct runs having air velocity of 1000 fpm (5 m/s) or more shall be isolated from the building structure by Type 11 hangers or 5 floor supports. Spring deflection shall be a minimum of 0.75 inch (19 mm).

B. Seismic restraint of ductwork:
1. Seismically restrain all ductwork with Type 12 or Type 13 restraints as listed below:
   a. Restrain rectangular ducts with cross sectional area of 6 sq. ft. (0.5 sq m) or larger.
   b. Restrain round ducts with diameters of 28 inches (700 mm) or larger.
   c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
2. Transverse restraints shall occur at 30 feet (9 mm) 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 feet (18 m) 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 (1.2 m) 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 shall 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 weights and dimensions of the ducts are less than or equal to the maximum 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.
7. Connection to the structure shall be made with a non-friction connection (i.e. no C-clamps)
8. Hanger locations that also have seismic restraints attached shall have Type 10A RW Rebound Washers.

C. Ductwork Exclusions:
   1. Rectangular and square and ducts that are less than 6 square feet in cross sectional area.
   2. Oval ducts that are less than 6 square feet (0.5 sq m) in cross sectional area based on nominal size.
   3. Round duct less than 28-inch (0.71 m) diameter.
   4. Certain suspended ductwork
      a. All trapeze supported ductwork where the distance from the suspension point to the trapeze member is 12-inches or less.
      b. Ductwork hung with straps where the top of the duct is 12-inches or less from the suspension point and the strap has 2 #10 sheet metal screws within 2-inch of the top of the duct.
      c. If any suspension location in the run fails to qualify under (a) or (b) above, the entire run shall be braced.

3.04 ELECTRICAL SERVICES

A. Seismic Restraint:
   1. All electrical conduit 2-1/2-inch (64 mm) in diameter and larger shall be restrained with Type 12 seismic cable restraints or Type 13 for seismic solid brace restraints.
   2. All electrical bus ducts, cable trays and ladder trays shall be restrained with Type 12, seismic cable restraints or Type 13 seismic solid brace restraints.
   3. Transverse restraints shall occur at 30 feet (9 m) 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 feet (18 m) 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 feet (1.2 m) of the intersection of the electric run and if the restraints are sized for the larger electric run.
   5. All floor mounted transformers, motor starters, switchgears and substations shall have a resilient media between the equipment mounting hole and the anchor bolt. Anchor bolts shall be designed in accordance with seismic forces shown on Structural Drawings. Neoprene bushings shall be Type 4 and anchor bolts shall be Type 18 or Type 19.
   6. Wall mounted panels, transformers and motor starters shall be mounted with Type 3 bushings. Floor mounted panels shall be mounted on Type 4 bushings. Anchor bolts shall be Type 18 or Type 19.
   7. All generators shall be mounted on a Type 21 concrete inertia base, with Type 5 spring isolators and Type 17 seismic snubbers.
   8. Connection to the structure shall be made with a non-friction connection (i.e. no C-clamps)

B. Exclusions:

1. All conduit less than 2-1/2 inches (64 mm) diameter suspended by individual hanger rods.
2. Certain Suspended Conduit:
   a. All conduits suspended by clevis hangers where the distance from the top of the conduit to the suspension point is 12 inches (300 mm) or less.
   b. All trapeze supported conduits, bus ducts and cable trays where the distance from the suspension point to the trapeze member is 12 inches (300 mm) or less.
   c. If any suspension location in the run fails to qualify under (a) or (b) above, the entire run shall be braced.

END OF SECTION