PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SUMMARY

A. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

C. All mechanical equipment, piping and ductwork as noted on the equipment schedule, in the specification or as required by code shall be designed to resist seismic forces. Refer to Section 230549 Seismic Restraint for Piping, Ductwork and Equipment

D. This Section includes the following:
1. Vibration Isolation pads.
2. Vibration Isolation mounts.
3. Restrained uni-directional seismic isolation snubber mounts.
4. Spring isolators.
5. Housed seismic spring vibration mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Air-mounting system.
12. Restrained vibration isolation roof-curb rails.
13. Seismic snubbers.
14. Seismic Restraining braces and cable systems for equipment, piping, and ductwork.
15. Vibration isolation equipment bases.
16. Flexible piping connectors
17. Flexible ductwork connectors

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic HVAC Materials and Methods

B. Section 230549: Seismic Restraint for Piping, Ductwork and Equipment

1.4 DEFINITIONS

A. AHJ: Authority Having Jurisdiction

B. IBC: International Building Code with State Amendments.

C. ICC-ES: ICC-Evaluation Service.

D. OSHPD: Office of Statewide Health Planning and Development for the State of California. Nationally recognized state enforcement agency for certifying and seismic restraint systems.

1.5 CODES AND STANDARDS

A. Provide components conforming to the load requirements of the latest addition of the local building code and the following:
   1. 2012 International Building Code with AHJ Amendments
   2. American Society of Civil Engineers (ASCE):
      a. ASCE 7-10: Minimum Design Loads for Buildings and Other Structures
   3. The Manufacturers Standardization Society (MSS):
      a. MSS SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
      b. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
      c. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices
      d. MSS SP-127: Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.
   4. Mason West Inc. Seismic Restraint Guidelines 2014 Edition
      a. OPM-0043-13 for all suspended piping, suspended ductwork and suspended electrical raceways

1.6 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Seismic forces for new installations are determined per ASCE/SEI 7-05. Refer to Structural Design for seismic factors and design criteria. Select and submit appropriate values for each piece of equipment and sub-system and material type for the project, and base the seismic calculations on these values.
   2. Refer to Section 230549 Seismic Restraint for Piping, Ductwork and Equipment for seismic specific requirements.
   3. Coordinate all seismic and load requirements with the registered professional Structural Engineer.

B. Component Importance Factor:
   1. Ip=1.0: Standard Occupancies and components associated with Risk Category I, II, and III, including offices and schools.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Building Structural Limits: The design of supports and restraints shall not exceed the building structure allowable point loads. Coordinate all work with the registered professional Structural Engineer.

1.8 SUBMITTALS

A. Product Data shall include the following:
1. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
3. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
4. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
   b. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:
1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
2. Provide all details of suspension and support for ceiling hung equipment.
3. Where walls, floors, slabs or supplementary steel work are used for seismic restraint the locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and where required wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include

certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads. Provide base with level top surfaces with integral sloping on bottom to match support structure.

D. Coordination Drawings: Show coordination and plan locations of seismic bracing for HVAC piping, ductwork, and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Qualification Data: Devices shall be selected to meet seismic and support requirements by a registered professional Structural Engineer.

~~F. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent test agency.~~

~~G.~~**F.** Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS AND APPLICATION

A. Factory Finishes:
1. Standard paint applied to factory-assembled equipment before shipping.
2. Powder coating on springs and housings.
3. All hardware shall be galvanized or powder coated.
4. Hot-dip galvanized or powder coating of metal components for exterior use.
5. Baked enamel or powder coat for metal components for interior use.

B. Glumac Device Key Schedule: Part 3 of this Section schedules the application of devices described in Part 2 for use with mechanical equipment found on this project. The tag designation of preferred devices is as follows:

~~Glumac~~ Isolator Tag	**Description**
P-1	Vibration isolation waffle pad
P-2	Double deflection neoprene mount
P-3	Uni-directional restrained neoprene snubber mount
P-4	Interlocking uni-directional snubber
S-1	Open spring vibration isolator
S-2	Steel housed seismic spring vibration isolator
S-3	Bellows air spring isolator
S-4	Restrained air spring isolator
C-1	Seismic spring isolation roof curb (20 ton HVAC and below)
C-2	Seismic spring isolation roof curb (Greater than 20 ton HVAC)
C-3	Curb mounted spring isolation roof base
B-1	Integral equipment and motor base

B-2	Integral equipment and motor base
B-3	Concrete filled steel inertia base
H-1	Spring and rubber in shear vibration isolation hanger
G-1	All-directional pipe anchor
G-2	Vertical pipe guide
G-3	Horizontal thrust restraint
SB-1	Sway bracing
F-1	Kevlar/rubber spherical type flexible piping coupling
F-2	Stainless hose flexible piping coupling
F-3	Flexible expansion joints
F-4	Flexible ductwork connector

2.2 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Mason, basis of selection or equal by
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Kinetics Noise Control.
5. Vibration Eliminator Co., Inc.
6. Vibration Isolation.
7. Vibration Mountings & Controls, Inc
8. Vibro-Acoustics, Inc
9. Vibrex

B. P-1 Style: Neoprene pads shall consist of a 3/4" (19 mm) thick neoprene pad molded in square waffle modules, a minimum 1/4” (6 mm) thick steel load distribution plate and 3/4” (19 mm) hole with a neoprene anchor bolt bushing with a flat washer face. Pads may be single or multiple layers as required for leveling. Pads shall be Mason #MBSW Series or equal.

C. P-2 Style: Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) 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 Mason #BR Series or equal.

D. P-3 Style: 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” (6 mm) thick. A minimum air gap of 1/8” (3 mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. No sharp edges such as bolt threads may come in contact with the neoprene bushing. Snubber end caps shall be removable to allow inspection of internal clearances. Snubber shall be Mason #Z-1225 Series or equal.

E. P-4 Style: 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" (19 mm) 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" (3 mm) nor more that 1/4" (6 mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (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" (12 mm) deflection in the x, y and z planes. Snubbers shall be Mason #Z-1011 Series or equal.

F. S-1 Style: Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Two base plate holes for attachment to support surface. Isolators shall be Mason #SLFH Series or equal.

G. S-2 Style: Restrained spring mountings shall include springs that are free standing and laterally stable and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the spring and the mounting base plate. All spring assemblies shall have leveling bolts. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8” (9 m) shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall be Mason #SLR Series or #SLRS Series for steel/wood connections and Mason #SLREBP Series or #SLRSEBP Series or #SSLFH Series for concrete connections, or equal.

H. S-3 Style: Multiple bellow air springs shall be manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. All air spring systems shall be equipped with three (3) leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Air springs shall be Mason #MT and leveling valves Mason #LV, or equal.

I. S-4 Style: Restrained mountings shall include multiple bellow air springs manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8” (9 mm) shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall have test reports or calculations certifying the maximum allowable horizontal and vertical load ratings. All air spring systems shall be equipped with three (3) leveling valves

connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Mountings shall be Mason #SLR-MT for steel connections and Mason #SLREBP for concrete connections and leveling valves Mason #LV, or equal.

2.3 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-1) (HVAC UNITS 20 TON AND UNDER CAPACITY)

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Mason, basis of selection or equal by
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Thybar Corporation.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc
10. Vibro-Acoustics, Inc.

B. C-1 Style: Curb mounted rooftop equipment shall be mounted on spring isolation curbs. Curbs shall consist of continuous sheet metal frames above and below isolators. Isolators shall be adjustable, free-standing and laterally stable and include a 1/4” (6 mm) acoustical neoprene cup and leveling bolt. Spring diameters shall be no less than 0.8 of the compressed height of the spring at the rated load with 50% additional travel to solid. Seismic snubbers with an all directional neoprene bushing and 1/4” (6 mm) air gap shall be incorporated into each corner. A continuous sheet metal flashing shall be attached to the upper frame and be separated from the lower frame by a neoprene weatherseal. The sheet metal flashing shall incorporate removable cover plates for adjustment and inspection of isolators after the unit is set. The unit must be solidly fastened to the top steel frame and the lower sheet metal curb must be attached to the roof structure. Curb shall be Mason #ISC Series or equal.

C. C-3 Style: Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the rigid roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal. Aluminum members shall house electro-galvanized or powder coated springs selected for 0.75” (20 mm) minimum deflection. Travel to solid shall be 1.5” (40 mm) minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4” (6 mm) so as not to interfere with the spring action except in high winds. Manufacturer’s self adhering closed cell sponge gasketing must be used both above and below the base and a flexible EPDM duct like connection shall seal the outside perimeter. Foam or other sliding or shear seals are unacceptable in lieu of the EPDM ductlike closure. Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. Curb mounted bases shall be Mason #CMAB Series or equal.

2.4 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-2) (HVAC UNITS OVER 20 TON CAPACITY)

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Mason, basis of selection or equal by
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Thybar Corporation.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc
10. Vibro-Acoustics, Inc.

B. C-2 Style: 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 bushings shall be a minimum of 1/4" (6 mm) thick. Steel springs shall be laterally stable and rest on 1/4" (6 mm) 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" (50 mm) 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 be Mason #RSC Series or equal.

2.5 VIBRATION ISOLATION STEEL EQUIPMENT BASES

A. Basis-of-Design Product: Subject to compliance with requirements provide a comparable product by one of the following:
1. Mason, basis of selection or equal by
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation.
8. Vibration Mountings & Controls, Inc
9. Vibro-Acoustics, Inc.

B. B-1 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded structural steel angle or channel members. Base shall be Mason #MSL Series or equal.

C. B-2 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment

of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded wide flange structural steel main members with cross bracing located at or near each restraint location. Where height saving brackets are required, they shall be employed in all mounting locations to maintain a 1" (25 mm) clearance below the base. Base shall be Mason #WFSL Series or equal.

D. B-3 Style: 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 and shall be 6”deep for pumps thru 75 HP and 10” deep for pumps 100 HP thru 250HP. Forms shall include minimum concrete reinforcing consisting of #4 bars welded in place on 6" centers running both ways in a layer 1-1/2" 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" clearance below the base. Base shall be Mason #BMK Series or #KSL Series or equal.

2.6 SPRING HANGERS

A. H-1 Style: Spring hangers shall consist of rigid steel frames containing minimum 1-1/4” (32 mm)thick neoprene elements at the top and steel springs that are free standing and laterally stable seated in a steel washer reinforced neoprene cup at the bottom. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have a neoprene bushing projecting through the steel box. A seismic rebound washer made of steel and surrounding neoprene shall be provided. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc from side to side before contacting the rod bushing and short circuiting the spring. Hangers shall be Mason #RW30N Series or equal.

2.7 PIPE GUIDES AND SUPPORTS

A. G-1 Style: All-directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 1/2" (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 and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be Mason #ADA Series or equal.

B. G-2 Style: Vertical sliding pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (20 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 1-5/8" (41 mm) upwards or downwards motion, or to meet location requirements. Pipe guides shall be Mason #VSG Series or equal.

C. G-3 Style: Horizontal thrust restraints shall consist of a spring element seated in a steel washer reinforced neoprene cup at the bottom, in series with a molded neoprene element. Steel springs shall be free standing and laterally stable. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated

load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The 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" (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 Mason #WBI Series or #WBD Series or equal.

2.8 SWAY BRACING

A. SB-1 Style: Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles or struts. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of two (2). Brace end connections shall be steel assemblies that swivel to the final installation angle. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Do not mix cable and steel braces to brace the same system or equipment. Brace assemblies and rod clamps shall have an Anchorage Preapproval "OPM" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable brace assemblies shall be Mason #SCB Series or #SCBH Series, steel brace assemblies shall be Mason #SSB Series, #SSBS Series or #SHB Series, and rod clamps shall be Mason #SRC Series or #UCC Series or equal.

2.9 FLEXIBLE PIPING CONNECTORS

A. F-1 Style: Flexible spherical expansion joints for pump connections. Shall employ peroxide cured EPDM in the covers, liners and Kevlar 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" 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 16" to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190F with a uniform drop in allowable pressure to 190 psi at 250F. 16" and larger connectors are rated 180 psi at 190F and 135 psi at 250F. 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. Manufacturer shall provide pre-stretching charts for expansion joints when used in conjunction with isolated equipment. Control rods need only 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 1/2" 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 Mason #SAFEFLEX SFDEJ Series, #SAFEFLEX SFEJ Series, #SAFEFLEX

SFDCR Series or #SAFEFLEX SFU Series and Control Rods Mason #CR, or equal.

B. F-2 Style: Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" (75 mm) and larger shall be flanged. Smaller sizes shall have male threaded nipples or copper sweat ends. Hoses must have sufficient length, minimum 12” (300 mm) long, to accept 1/2” (12 mm) intermittent motion without failure. 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 Mason #FFL Flanged Series, #CPSB Copper Sweat Series or #CSAMN Threaded Series, or equal.

C. F-3 Style: Flexible Vee or U-bend braided hose across building or expansion joints. Piping and equipment connections shall be protected against seismic damage by the insertion of braided flexible hose Vee assemblies rated for ±4” (100mm) seismic motion in all planes. Should the application include ±6” (150mm) thermal movement or thermal movement alone, install the Vee so the thermal movement is axial. Vees shall have a minimum burst pressure of four times their rated pressure. Vees in steel lines shall have stainless hose and braid. Copper lines, bronze hose and braid. Guiding and anchoring shall be as recommended by the manufacturer. 60° Vees shall be Mason #VFL flanged braided steel Series, #VMN Threaded Braided Stainless Steel Series or #VCPSB Copper Sweat Series, or equal.

2.10 FLEXIBLE DUCTWORK CONNECTORS

A. F-4 Style: Flexible ductwork connection fabricated of fiberglass canvas with fire resistant rated neoprene and UV resistant coating. Stainless steel metal edge banding. Minimum 4” width: DuroDyne “Durolon” or “Neoprene”, or equal.

2.11 BRACING DEVICES FOR EQUIPMENT, PIPING, AND DUCTWORK.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. California Dynamics Corporation
3. Cooper B-Line, Inc.
4. Hilti, Inc.
5. Kinetics Noise Control
6. Loos & Co.
7. Mason Industries
8. Tolco Incorporated
9. Unistrut
10. ISAT, Inc
11. Vibro-Acoustics, Inc.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least two (2) times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4" (6 mm) thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Hanger Rod Stiffener: Steel tube, steel slotted support system sleeve or reinforcing steel angle clamped to hanger rod are acceptable.

F. Bushings for Floor-Mounted Equipment Anchorage: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.

J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 - EXECUTION

3.1 LOCATION AND APPLICATION OF VIBRATION ISOLATION EQUIPMENT

A. The following Tables provide schedules for vibration devices required for isolation of mechanical equipment provided on the project. Refer to Part 2 above for device specifications.

B. Air Handling Units Equipment Isolation

TABLE 1: EQUIPMENT ISOLATION SCHEDULE – AIR HANDLING UNITS

EQUIPMENT	LOCATION								
	CRITICAL ROOF OR FLOOR (35' - 50' SPAN)			UPPER STORY (20' - 35' SPAN)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
FLOOR MOUNTED									
Up to 15 HP	S-1 (1)	1.5	B-1 (1)/B-3	S-1 (1)	0.75	B-1	S-1 (1)	0.75	NA
20 HP & Over	S-1 (1)	2.5	B-1 (1)/B-3	S-1 (1)	1.5	B-2	S-1 (1)	0.75	NA
SUSPENDED (4)									
Up to 15 HP	H-1	1.75	B-1(1)/B-3	H-1	1.0	B-1	H-1	1.0	NA
20 HP & Over	H-1	2.5	B-1 (1)/B-3	H-1	1.75	B-1	H-1	1.0	NA
HIGH PRESSURE FAN SECTIONS (≥5" ESP)									
Up to 30 HP	S-2	2.5	B-2	S-2/S-1	1.5	B-2	S-2/S-1	0.75	B-2
40 HP & Over	S-2	3.5	B-2	S-2/S-1	2.5	B-2	S-2/S-1	1.5	B-2

Notes:
(1) Alternate: Factory installed by equipment manufacturer factory installed.
(2) Provide full perimeter steel welded frame below equipment
(3) Provide support per manufacturer's recommendation
(4) For pipe and duct connections provide F-2 pipe and F-3 duct connectors.

C. Unhoused Fans, Built-up Systems or Cabinet Fans Equipment Isolation

TABLE 2: EQUIPMENT ISOLATION SCHEDULE – UNHOUSED FANS, BUILT-UP SYSTEMS, OR CABINET FANS

EQUIPMENT	LOCATION								
	CRITICAL ROOF OR FLOOR (35' - 50' SPAN)			UPPER STORY (20' - 35' SPAN)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
CENTRIFUGAL FANS									
CL I & II Up to 54-1/2" WD									
Up to 15 HP	S - 2/S - 1	1.5	B-1/B-3	S-2/S-1	0.75	B-1	S-2/S-1	0.75	B-1
20 – 50 HP	S-2	2.5	B-2	S-2/S-1	1.5	B-2	S-2/S-1	0.75	B-1
60 HP & Over	S-2	3.5	B-2	S–2	2.5	B-2	S-2/S-1	1.5	B-1
CL I &II 60"W.D & OVER/ALL CL III FANS									
Up to 15 HP	S-2	2.5	B-2	S-2/S-1	1.5	B-1	S-2/S-1	0.75	B-1
20 – 50 HP	S-2	2.5	B-2	S-2	2.5	B-1	S-2/S-1	1.5	B-1
60 HP & Over	S-2	3.5	B-2	S-2	2.5	B-1	S-2/S-1	1.5	B-1
AXIAL FLOWFANS									
Floor Mtd.									
Up to 15 HP	S-1/S-2	1.5	B-1/B-3	S-1	0.75	B-1	S–1	0.75	NA
20 HP & Over	S - 2	3.5	B-2	S-1	1.5	B-2	S-1	0.75	NA
Suspended									
Up to 15 HP	H - 1	1.75	B-1/B-3	H-1	1.0	B-1	H–1	1.0	NA
20 HP & Over	H - 1	2.5	B-1/B-3	H-1	1.75	B-1	H-1	1.5	NA
UTILITY FAN SETS									
Floor Mounted	S - 2/S - 1	1.5	B-1/B-3	S-1	0.75	B-1	S-1	0.75	NA
Suspended	H-1	1.75	B-1/B-3	H-1	1.0	B-1	H-1	0.75	NA
CABINET FANS and FAN SECTIONS									
Floor Mounted									
Up to 15 HP	S-1(1)	1.5	NA	S-1	0.75	NA	S-1	0.75	NA
20 HP & Over	S-2(1)	2.5	B-2	S-1	1.5	NA	S-1	0.75	NA
Suspended									
Up to 15 HP	H-1	1.75	NA	H-1	1.0	NA	H-1	0.75	NA
20 HP & Over	H-1	2.5	NA	H-1	1.75	NA	H-1	1.75	NA

Notes:
(1) Alternate: Factory installed by equipment manufacturer.

(2) Provide full perimeter steel welded frame below equipment
(3) Provide support per manufacturer's recommendation
(4) For pipe and duct connections provide F-2 pipe and F-3 duct connectors.

D. Pumps – Equipment Isolation

TABLE 3: EQUIPMENT ISOLATION SCHEDULE – PUMPS

EQUIPMENT	LOCATION								
	CRITICAL ROOF OR FLOOR (35' - 50' SPAN)			UPPER STORY (20' - 35' SPAN)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
PUMPS									
Base and Close Coupled Floor Mounted									
Up to 5 HP	S–2/S-1	0.75	B-2	S–2/S-1	0.75	B-1	S–2/S-1	0.4	B-1
7-1/2 HP & Over	S–2/S-1	1.5	B-2	S–2/S-1	1.5	B-2	S–2/S-1	0.75	B-2
Vertical Split Case Floor Mounted									
Up to 5 HP	P-1	0.15	NA	P-1	0.15	NA	P-1	0.15	NA
7-1/2 HP & Over	S–2/S-1	1.5	B-2	S–2/S-1	1.5	B-2	P-1	0.15	NA
Suspended Inline	H-1	1.75	NA	H-1	1.75	NA	H-1	1.0	NA

Notes:
(1) Alternate: Factory installed by equipment manufacturer.
(2) Provide full perimeter steel welded frame below equipment
(3) Provide support per manufacturer's recommendation
(4) Provide F-1 flexible connector for all high horsepower pumps, F-2 connector for fractional horsepower pumps.

E. Cooling Plant/Refrigeration Equipment Isolation

~~TABLE 4: EQUIPMENT ISOLATION SCHEDULE – REFRIGERATION/COOLING PLANT EQUIPMENT~~									
~~EQUIPMENT~~	~~LOCATION~~								
	~~CRITICAL (35' – 50' SPAN)~~			~~UPPER STORY (20' – 35' SPAN)~~			~~ON GRADE~~		
	~~ISOLATOR TYPE~~	~~MINIMUM DEFLECTION (IN)~~	~~BASE TYPE~~	~~ISOLATOR TYPE~~	~~MINIMUM DEFLECTION (IN)~~	~~BASE TYPE~~	~~ISOLATOR TYPE~~	~~MINIMUM DEFLECTION (IN)~~	~~BASE TYPE~~
	~~TYPE~~	~~DEFLECTION~~	~~TYPE~~	~~TYPE~~	~~DEFLECTION~~	~~TYPE~~	~~TYPE~~	~~DEFLECTION~~	~~TYPE~~
~~**REFRIGERATION UNITS**~~									
~~Scroll type Condensing units and Compressors~~	~~S-2~~	~~2.5~~	~~B-2~~	~~S–2/S-1~~	~~1.5~~	~~B-1~~	~~P-1~~	~~0.15~~	~~NA~~
~~Reciprocating Cond. Units & Chillers~~	~~S-2~~	~~2.5~~	~~B-2~~	~~S-2~~	~~1.5~~	~~B-2~~	~~S-1~~	~~0.75~~	~~NA~~
~~Scroll Chillers~~	~~S-2~~	~~2.5~~	~~(2)~~	~~S-2~~	~~1.5~~	~~(2)~~	~~P-1~~	~~0.15~~	~~NA~~
~~Screw Chillers~~	~~S-2~~	~~2.5~~	~~(2)~~	~~S-2~~	~~1.5~~	~~(2)~~	~~P-1~~	~~0.15~~	~~NA~~
~~Hermetic Centrifugal Chillers~~	~~S-2~~	~~2.5~~	~~(2)~~	~~S-2~~	~~1.5~~	~~(2)~~	~~P-1~~	~~0.15~~	~~NA~~
~~Open Centrifugal Chillers~~	~~S-2~~	~~2.5~~	~~(2)~~	~~S–2/S-1~~	~~1.5~~	~~(2)~~	~~P-1~~	~~0.15~~	~~NA~~
~~Absorption Chillers~~	~~S-2~~	~~1.5~~		~~S-2~~	~~0.75~~	~~NA~~	~~P-1~~	~~0.15~~	~~NA~~
~~**COOLING TOWERS & CLOSED CIRCUIT COOLERS**~~									
~~Up to 500 Tons~~	~~S-2~~	~~2.5~~	~~(3)~~	~~S–2~~	~~0.75~~	~~(3)~~	~~P-1~~	~~0.15~~	~~(2)~~
~~Over 500 Tons~~	~~S-2~~	~~4.5~~	~~(3)~~	~~S-2~~	~~2.5~~	~~(3)~~	~~P-1~~	~~0.15~~	~~(2)~~

~~Notes:~~
~~(1) Alternate: Factory installed by equipment manufacturer.~~
~~(2) Provide full perimeter steel welded frame below equipment~~
~~(3) Provide support per manufacturer's recommendation~~
~~(4) Provide F-2 pipe connections to unit.~~

F. Miscellaneous Equipment Isolation

TABLE 5: EQUIPMENT ISOLATION SCHEDULE – MISCELLANEOUS EQUIPMENT

EQUIPMENT	LOCATION								
	CRITICAL (35' - 50' SPAN)			UPPER STORY (20' - 35' SPAN)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
	TYPE	DEFLECTION	TYPE	TYPE	DEFLECTION	TYPE	TYPE	DEFLECTION	TYPE
ROOFTOP AIR CONDITIONING UNITS									
Up to 20 Ton	S-2	1.5	C-1/C-3	S-2	1.5	C-1/C-3	NA	NA	NA
Over 20 Ton	S-2	2.5	C-2	S-2	2.5	C-2	NA	NA	NA
BOILER (PACKAGE TYPE)									
All Sizes	P-1	0.15	(3)	P-1	0.15	(3)	P-1	0.15	(3)
ENGINE DRIVEN GENERATORS									
Up to 60 HP	S-2	2.5	B-2	S-2	1.5	B-2	S-2	0.75	NA
75 HP & Over	S-2	3.5	B-2	S-2	2.5	B-2	S-2	0.75	NA

Notes:
(1) Alternate: Factory installed by equipment manufacturer.
(2) Provide full perimeter steel welded frame below equipment
(3) Provide support per manufacturer's recommendation
(4) For pipe and duct connections to units provide F-2 pipe and F-3 duct connectors.

3.2 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service or agency acceptable to authorities having jurisdiction. Indicate on Drawings, by details, schedules, or a combination of both, the locations where hanger rods for individual pipes and hanger rods for trapeze hangers require hanger rod stiffeners.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

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

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

D. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

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

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

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 architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor’s expense.

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

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

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

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

L. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction. Provide required submittals for components.

M. Piping Restraints:
1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12m) and longitudinal supports a maximum of 80 feet (24m).
3. Brace a change of direction longer than 12 feet (3.7m).

N. Install cables so they do not bend across edges of adjacent equipment or building structure.

O. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction, providing required submittals for component.

P. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.

Q. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

R. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

S. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.5 VIBRATION ISOLATION OF PIPING

A. Horizontal Piping: The first three pipe supports from vibration isolated equipment must be vibration isolated. The static deflection of the pipe support isolators must be equal to the static deflection for the isolators under the connected equipment. Overhead piping shall suspend from Mason Type 30N spring hangers, or equal. Floor supported piping shall rest on Mason Type SLR isolators, or equal. Refer to contract drawings for additional vibration isolation requirements for piping. Where piping connects to mechanical equipment install Mason Type SFDEJ or SFU expansion joints or Mason Type FFL stainless hoses if Type SFDEJ or SFU is not suitable for the service.

B. Riser isolation: Risers that experience excessive thermal expansion shall be suspended from Mason Type 30N spring hangers or supported by Mason Type SLF(H) spring mountings, anchored with Mason Type ADA(H) anchors, and guided with Mason Type VSG(H) sliding guides. Horizontal pipe runs and branches shall be supported on Mason Type 30N spring hangers for the first three supports from the risers. Steel springs shall be selected to provide a minimum of 0.75"static deflection except in those expansion locations where additional deflection is required to limit load changes to ± 25% of the initial load. Submittals must 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.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

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

3.7 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.8 AIR MOUNTING SYSTEM DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division

01 Section "Demonstration and Training."

END OF SECTION