SECTION 230548 - VIBRATION ISOLATION FOR PIPING, DUCTWORK, AND EQUIPMENT

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 curbs, pads and mounts.
2. Flexible ductwork connectors
3. Spring hangers with and without vertical-limit stops.
4. Spring isolators.
5. Restrained uni-directional seismic isolation snubber mounts.
6. Elastomeric hangers.
7. Resilient pipe guides.
8. Seismic snubbers.

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. FRT: Fire retardant treated wood is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a listed flame spread index of 25 or less.

C. IBC: International Building Code with State Amendments.

D. ICC-ES: ICC-Evaluation Service.

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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. International Building Code with AHJ Amendments
2. American Society of Civil Engineers (ASCE):
    a. ASCE 7 (Latest Edition): 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. For all suspended piping, suspended ductwork and suspended electrical raceways.

1.6 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Refer to Section 230549 Seismic Restraint for Piping, Ductwork and Equipment for seismic specific requirements.
2. Vibration isolators must be rated for the seismic loading associated with the system and forces calculated for this building location. Seismic forces for new installations are determined per ASCE 7. 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.
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.
2. Ip=1.5: Components associated with Risk Category IV Buildings (Essential Services); or for conditions outlined in ASCE 7 Section 13.1.3 regardless of Risk Category; or Hospitals and Correctional Treatment Centers. Components include, but are not limited to the following:
    a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems.

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b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.

1.7 QUALITY ASSURANCE

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

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

C. 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.

D. Special Inspections: Provide structural design and Special Inspections as required by Chapter 17 of the IBC, the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. Per IBC Section 1705 all anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner's Representative.

1.8 WARRANTY

A. Provide minimum one-year warranty requirements, including all parts, material, labor and travel.

B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

1.9 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.

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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. Manufacturer Design Submittal: For vibration isolation 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. 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 vibration isolation for HVAC ductwork, piping, 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. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.10 WARRANTY

A. Refer to section 230500 for basic warranty requirements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS AND APPLICATION

A. Factory Finishes:

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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
H-1	Spring and rubber in shear vibration isolation hanger
SB-1	Sway bracing
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
2. Amber/Booth Company (VMC Group)
3. California Dynamics Corporation.
4. Kinetics Noise Control.
5. Vibration Eliminator Co., Inc.
6. Vibration Isolation.
7. Vibration Mountings & Controls (VMC Group)
8. Vibro-Acoustics, Inc
9. Vibrex
10. VMC Group

2.3 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. Manufacturers: Mason #RW30N Series or equal.

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2.4 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. Manufacturers: 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.

2.5 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.

B. Flexible Connections (Indoor Applications):

1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
2. Neoprene (polychloroprene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame.
3. Shall be airtight, watertight and fire retardant.
4. Minimum density of 30 oz. per sq. yard.
5. Temperature range: -40°F to 200°F
6. Surface-Burning Characteristics: Maximum flame-spread index of 20 and maximum smoke-developed index of 40 when tested according to UL 723/ASTM E84.
7. Neoprene-only connectors are not allowed.
8. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal.
9. Manufacturers: Ventfabrics #Ventglas or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.

2.6 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 (VMC Group)
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

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9. Unistrut
10. ISAT, Inc
11. Vibro-Acoustics, Inc.
12. VMC Group

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.

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PART 3 - EXECUTION

3.1 LOCATION AND APPLICATION OF VIBRATION ISOLATION EQUIPMENT

A. The following Tables provide schedules for minimum vibration devices required for isolation of mechanical equipment provided on the project. Refer to Part 2 above for device specifications. Coordinate with additional requirements recommended by device manufacturers. Sizes show below take precedent as the minimum requirements. Use the greater of the sizes shown as follows or shown on the drawings.

3.2	EQUIPMENT LOCATION								
EQUIPMENT TYPE	ROOF AND FLOORS ON GREATER THAN 30' FLOOR SPAN (5)			UPPER FLOOR UP TO 30' FLOOR SPAN			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
SUSPENDED									
Dual Duct Terminal Units	H-1	1.75	NA	H-1	1.0	B-1	H-1	1.0	NA

Notes:
(1) Provide support per manufacturer's recommendation
(2) Span is the beam or girder distance between columns or exterior fixed wall supports.

3.3 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.

3.4 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.

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3.5 VIBRATION-CONTROL DEVICE INSTALLATION

A. 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.

B. 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.

C. All vibration isolator systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

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

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

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 attention of the Owner’s Representative prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor’s expense.

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

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

I. 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.

J. 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.

K. 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.

L. 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

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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.

3.6 VIBRATION ISOLATION OF PIPING

A. Horizontal Piping: The first three pipe supports from vibration isolated equipment, including but not limited to pumps and chillers, must be vibration isolated to minimize fluid transmitted vibration into the building structure. The static deflection of the pipe support isolators must be equal to the static deflection for the isolators supporting the connected equipment. Overhead piping shall suspend from Mason Type 30N spring hangers or better. Floor supported piping shall rest on Mason Type SLR isolators or better. 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.

3.7 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.

3.8 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.

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END OF SECTION 230548

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