

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC AND PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Neoprene Pads;
2. Vibration Isolation Springs;
3. Pad Type Isolators;
4. Double Plate Type Isolators;
5. All-Directional Anchors;
6. Neoprene Mountings;
7. Spring Isolators, Free Standing;
8. Spring Isolators, Housed;
9. Spring Isolators, Vertically Restrained;
10. Spring Isolators, Earthquake Restrained;
11. Seismic Snubbers;
12. Equipment Rails;
13. Fabricated Equipment Bases;
14. Inertia Base Frames;
15. Isolation Hangers;
16. Riser Isolators;
17. Flexible Pipe Connectors;

B. Related Sections:

1. Division 03 - Cast-In-Place Concrete: Execution requirements for placement of isolators in floating floor slabs specified by this section and product requirements for concrete for placement by this section.
2. Division 07 - Joint Protection: Product requirements for joint sealers specified for placement by this section.
3. Division 23 - Hangers and Supports for HVAC and Plumbing Piping and Equipment: Product requirements for pipe hangers and supports.
4. Division 23 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this section.
5. Division 23 - Air Duct Accessories: Product requirements for both solid and flexible duct connectors for duct silencers specified for placement by this section.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

B. American National Standards Institute:

1. ANSI S1.4 - Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

- C. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.
- D. American Society of Heating, Refrigerating and:
 - 1. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
 - 2. ASHRAE Handbook - HVAC Applications.
- E. ASTM International:
 - 1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - 2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
 - 3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.
- F. Sheet Metal and Air Conditioning Contractors':
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 PERFORMANCE REQUIREMENTS

- A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping and ductwork.
- B. Provide minimum static deflection of isolators for equipment.
- C. Consider upper floor locations critical unless otherwise indicated.
- D. Exterior noise emission from HVAC system shall be limited to a level of 45 dBA at night and 50 dBA during the day at the property line.
- E. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.
- F. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook., HVAC Applications and ANSI S1.8.
 - 1. Offices
 - a. Executive: 30
 - b. Conference rooms: 30
 - c. Private: 30
 - d. Open-plan areas: 35
 - e. Computer/business machine areas: 40
 - f. Public circulation: 40

1.04 DESIGN REQUIREMENTS

- A. It is the intent of this Specification to provide the necessary design for the avoidance of excessive noise or vibration in the building due to the operation of machinery or equipment, or due to interconnected piping, or conduit, and to seismically restrain suspended utilities, per State of California Title 22 & 24, , California Building Code, against seismic force in any direction.

- B. All vibration isolators shall have either known undeflected heights or other markings so that, after adjustment when carrying their load, the deflection under load can be verified thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- C. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of not less than 50 percent above the design deflection.
- D. The ratio of lateral to vertical stiffness shall be not less than 0.9 or greater than 1.5.
- E. All neoprene mountings shall have a shore hardness of 40 to 65, after minimum aging of 20 days or corresponding oven aging.
- F. Design isolators to suit vibration frequency to be absorbed and the load imposed. Isolator units are to have adequate area and distribution to obtain proper resiliency under machine load and impact without permitting excessive movement when started.
- G. Wave motion through the isolator shall be reduced to the following extent: Isolation above the resonant frequency shall follow the theoretical prediction based upon an undamped single degree of freedom system with a minimum isolation of 50 decibels above 150 cycles per second.
- H. Vibration isolator spring diameter shall not be less than their deflected height. Select spring with a 50 percent overload safety factor.
- I. Unless otherwise indicated, all equipment mounted on vibration bases shall have a minimum operating clearance of 1 inch between structural steel base and floor or support base beneath. Check clearance space to insure that no scrap or hardware has been left to possibly short circuit isolation base.
- J. When necessary due to height limitations, provide structural steel bases with height savings brackets. Isolators shall have a method for leveling and where spring isolators are used shall have gussets on both sides of the isolators.
- K. Design isolators for positive anchorage against uplift and overturning.
- L. Provide and install under this Section of the Specification structural steel required to properly support and seismically restrained equipment & suspended utilities.
- M. Construction criteria and standards of seismic restraint design for suspended pipes, ducts and mechanical equipment shall be per the International Seismic Application Technology (ISAT) (877)999-ISAT or Mason.
- N. 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 piping and equipment isolation systems and seismic restraints as scheduled or specified.
 3. Guarantee specified isolation system deflection.
 4. Provide installation instructions, details and field supervision to assure proper installation and performance.
 5. Purchased and/or fabricated equipment must be designed to safely accept external forces of the required "G" load in any direction for all rigidly and resiliently supported equipment, and piping without failure and permanent displacement of the equipment. Life safety equipment such as fire pumps, sprinkler piping, emergency generators and machinery, must be capable of safely accepting external forces of the required "G" load in any direction without permanent displacement of the supported equipment. Substitution of "Internally Isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment unit.
 6. Secure State approval on all vibration and seismic restraints to be used on this project.

- O. Thermal, seismic, pressure and gravity load analysis on pipes: The supports, anchors, guides and seismic braces for all steam, condensate and heating hot water systems must be designed for combined gravity, seismic, pressure and thermal loads as defined in ASME B31.1 or ASME B31.9. The results of the analysis shall include reactions at restraints/anchors, pipe displacements and a code compliant report satisfying pipe stresses. Where required, provide expansion compensators, flexible connectors, guides and seismic restraints which shall be incorporated into the design of the system. The analysis and design must be performed by a registered civil or structural engineer hired by the Developer Design/Builder with at least 5 years of experience in the field.

1.05 SUBMITTALS

- A. Division 01 - Submittal Procedures: Submittal procedures.
- B. Submit in accordance with Division 1. Submit Shop Drawings and Manufacturer's Pre-Approved details for:
 - 1. Catalogue cuts, data sheets and installation instructions on specific vibration isolators and seismic restraints to be utilized showing compliance with the Specification.
 - 2. List showing the items of equipment, piping, etc., to be isolated and seismically restrained, the isolator type and model number selected, isolator loading and deflection, and reference to specific drawing showing frame construction where applicable. Also provide seismic restraint details.
 - 3. Drawings showing equipment frame construction for each machine including dimensions, structural member sizes, and support point locations, etc.
 - 4. Written approval of the frame design to be used, obtained from the equipment manufacturer.
 - 5. Drawings showing methods for suspension, support, restraint, guides, etc., for piping, etc.
 - 6. Drawings showing methods for isolation of pipes, etc., piercing slabs, beams, etc.
 - 7. Seismic restraint calculations
- C. Maintenance Data: Submit maintenance data for each type of vibration control product. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.
- D. Submit calculations by a licensed Structural Engineer substantiating that equipment mountings and foundations, and their seismic restraints can meet the required external forces "G" load for all rigidly and resiliently supported equipment without failure and permanent displacement. Submit similar calculations for life safety equipment restraints for "G" loading. Restrain all resiliently mounted piping with cable seismic bracing .

1.06 CLOSEOUT SUBMITTALS

- A. Division 01 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of cross-talk silencers, acoustic housings and ductwork lagging. Record actual locations of hangers including attachment points.

1.07 QUALITY ASSURANCE

- A. Perform Work in accordance with standards and recommendations of ASHRAE 68.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

- C. Design application of duct silencers, acoustic housings and seismic snubbers under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location. in State of California.

1.09 PRE-INSTALLATION MEETINGS

- A. Division 01 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide vibration control products of one of the following:
 - 1. Vibration Mountings & Controls, Inc.
 - 2. Mason Industries, Inc.
 - 3. M. W. Sause & Co., Inc. (VIBREX)
 - 4. Cal-dyn.
- B. Except as otherwise indicated mechanical equipment shall be isolated from the structure by means of resilient vibration and noise isolators supplied by a single manufacturer to the Developer Design/Builder.

2.02 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

- A. Type and Description:
 - 1. Type PN is a molded pad. The area of pad shall be chosen to match the load in order to achieve the required static deflection.
 - 2. Type HN is a suspension hanger with a steel box frame and molded neoprene in shear element. A neoprene grommet shall be provided at locations where hanger rod passes through the hanger box so that metal to metal contact occurs.
 - 3. Type MSL is a bare, stable, steel spring with a ribbed neoprene pad under the base plate to permit attachment to the building structure. Limit stops shall be provided to prohibit spring extension if the load is removed. These stops may also serve as rigid blocking during erection so that the installed and operation heights shall be the same. Clearance shall be maintained around restraining bolts and between the limit stops and the housing so as not to interfere with the spring action.
 - 4. Type HS is a suspension hanger with a steel box frame and a steel spring resting on a neoprene cup. The cup shall contain a steel washer designed to evenly distribute the load to the neoprene and prevent its overload or extrusion. The spring diameter and hanger box lower hole size shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Hangers shall be provided with an eye bolt on the spring end.

5. Type HMS is a single spring vibration isolator built into a welded steel mount assembly designed and engineered to limit movement of supported equipment during an earthquake without degrading the vibration isolation of the spring during normal equipment operating conditions. The spring type isolator shall be laterally stable without any housing. 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 mounts shall incorporate a welded steel angle and plate motion limit assembly and steel spring isolator, engineered as a system to accept a force in any direction equal to a minimum of 1.3 times the rated load capacity of the spring isolator without the yield or failure and shall limit movement of the point of level bolt connection to supported equipment to 0.75" in any direction, relative to any fixed point on the mount assembly, while subjected to the minimum force specified. The motion limit assembly shall be welded to a steel base plate having a 1/4" thick ribbed neoprene noise stop pad and drilled holes for bolting to supporting structures. A spring isolator drilled and taped load plate and leveling bolt assembly shall be positioned by weld studs on the base plate, and shall carry all normal equipment operating loads.
6. Type SF - Flexible Pipe Connectors: Flexible neoprene pipe connectors shall be used at pump connections. They shall be manufactured of multiple plies of nylon tire cord fabric and neoprene both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement. Straight connectors shall have two spheres. Neoprene elbows shall be manufactured with a single sphere forming the corner of the joint itself. Connectors up to and including 2 inch diameter may have threaded ends. Connectors 2-1/2 inches and larger shall be manufactured with floating steel flanges recessed to lock the connector's raised face neoprene flanges. All connectors shall be rated a minimum of 150 psi at 220 degrees F. All straight through connections shall be made with either flanged or screwed twin spheres properly pre-extended as recommended by the manufacturer to prevent additional elongation under pressure. Connectors shall be provided with control units, in accordance with the manufacturer's recommendations, to limit expansion.
7. Type HMN is a neoprene isolator incorporating a steel housing capable of resisting a seismic load of 1.0 G in all directions. The mount shall consist of a captive steel insert embedded into a neoprene element which is enclosed by a steel housing which also includes floor mounting holes. The isolator shall have a rated deflection of 0.15 inches compression, 0.12 inches in tension and 0.09 inches in shear.
8. Type PGA is an all direction acoustical pipe anchor or guide consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2 inch thickness of heavy duty neoprene material. Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.

Type	Description	Manufacturer's Designation			
		Amber Booth	California Dynamics	Mason Industries	Sause Vibrex
HMN	Housed Neoprene Mount	BRD	RQ	HNM	
MSL	Spring Mount with Lomit Stop	CT	OS	SLR	RMLS
HS	Spring Hanger	BSS	CH30	W30	RMX
HMS	Housed Spring Mount	WSPQ	SWSR	SSLFH	RMSP
SF	Flex Connector			MFTNC	CFLEX
PN				W	R
PGA				ADA/RPA	

2.03 EQUIPMENT FRAMES

- A. General: Mounting frames and/or brackets shall be provided to carry the load of the equipment without causing mechanical distortion or stress to the equipment.

B. Frame Types:

1. Type A frame is wide flange structure steel frame with brackets. The maximum allowable deflection of any point on the load frame relative to the unloaded frame shall be 0.005 inch. A wide flange section depth greater than 1/10 the length of the longest frame member will be accepted as satisfying the deflection requirement.
2. Type B frame is a channel steel structural frame with brackets. This section depth shall be greater than 1/10 the length of the longest frame member.
3. Type C no frame required, isolators directly attached to equipment.

2.04 SEISMIC RESTRAINTS

A. Type I, Equipment No Vibration Isolated: Attach to the structure with attachments to resist a lateral force loading of not less than 0.5 G.

B. Type II, Vibration Isolated Equipment:

1. Mount all vibration isolated equipment on rigid steel frames as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability.
2. Each vibration isolated frame shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment to the base and the structure.
3. The snubber shall consist of interlocking steel members restrained by shock absorbent rubber material compounded to bridge bearing Specifications.
4. Elastomeric materials, replaceable and a minimum of 3/4 inch thick. Snubbers, manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch. Install snubbers with factory set clearances.
5. The capacity of the seismic snubber at 3/8 inch deflection shall be 3 to 4 times the load assigned to the mount grouping in its immediate area. Submittals shall include the load deflection curves up to 1/2 inch deflection in the x, y, and z planes. Conduct test in an independent laboratory or under the signed supervision of an independent registered engineer. Bolt snubber assemblies to the test machine as the snubber is normally installed.
6. Test report shall certify that neither the neoprene elements nor the snubber body sustained any obvious deformation after release of load.

C. Seismic Restraint of Vibration Isolated Suspended Piping:

1. Use a slack cable system of a minimum 1/4 inch of steel at a minimum of 40 feet on center.
2. The cable size and attachment to the pipe and structure shall be designed and signed by a licensed structural engineer in the State of California.
3. Submittal drawing shall indicate proposed method of vertical restraint.
4. Cable shall be installed with sufficient slack to avoid short circuiting the vibration isolation.

D. Suspended Vibration Isolated Equipment:

1. Utilize a cable seismic bracing system.
2. The cable size and attachment must be designed and signed by a Structural engineer licensed in the State of California.
3. Submittal drawing shall indicate proposed method of vertical restraint.
4. Cable shall be installed with sufficient slack to avoid short circuiting the vibration isolation.

E. Seismic Restraint of Vibration Isolated Equipment: All floor mounted equipment shall be equipped with seismic restraints. Restraints shall be capable of withstanding a horizontal force equal to 1.0 times the equipment weight and a vertical force of 1/3 of the horizontal. The vibration isolation manufacturer shall design these restraints. The Developer Design/Builder shall submit details for approval.

2.05 DUCTWORK

- A. Flexible connections shall be incorporated in the ductwork adjacent to all fans and coil units.

2.06 ISOLATOR SPRINGS

- A. The spring diameters versus specified deflection shall be as follows:

Static Deflection	Spring O.D.
1.0"	2"
1.0"	3"
2.0"	4" or 6-1/2"
2.5"	6-1/2"
3.0"	8" or 9"

- B. Under no circumstances will smaller spring diameters be acceptable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Division 01 - Administrative Requirements: Coordination and project conditions.
- B. Verify equipment, ductwork and piping is installed before work in this section is started.

3.02 GENERAL

- A. The vibration isolation manufacturer, or his representative, shall be responsible for providing such supervision as may be necessary to assure correct installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer, or his representative, shall make a final inspection and submit his report to the County's Representative in writing, certifying the correctness of installation and compliance with approved submittal data.
- B. No equipment of pipe shall be installed which makes rigid contact with the "building" unless it is approved in this Specification or by the County's Representative. "Building" includes slabs, beams, studs, walls, latch, etc.
- C. Perform stress analysis per ANSI 31.1 for the steam and condensate drain lines. Provide complete support system for thermal and seismic load in addition to gravity and internal pressure.

3.03 MOUNTING

- A. Isolation Configuration for Floor Mounted or Suspended Equipment: Provide a maximum of four vibration isolators located at the corners of the equipment unless approval is obtained for additional isolators. Where feasible, provide three isolators.

3.04 EQUIPMENT ISOLATOR

- A. The equipment to be isolated shall be supported by a structural steel frame or by brackets attached directly to the machine where no frame is required.
- B. Brackets shall be provided to accommodate the isolator and provide a mechanical stop where indicated. The vertical position and size of the bracket shall be specified by the isolator manufacturer.

- C. The operating clearance between the bracket and the pad or floor shall be 3/8 inch + 1/16 inch. The minimum operating clearance between the frame and the pad or floor shall be 1 inch.
- D. The frame shall be placed in position and the brackets supported temporarily by 3/8 inch shims prior to the installation of the machine or isolators.
- E. After the entire system installation is completed and under full operation load, the isolator shall be adjusted so that the load is transferred from the shims to the isolator. When all isolators are properly adjusted, the shims shall be used as a gauge to check that the 3/8 inch clearance is maintained so that the system will remain free of stress.
- F. Provide concrete inertia base complete with spring isolators and snubbers for pumps.

3.05 INSPECTION

- A. On completion of installation of all noise, vibration and seismic control devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation error, improperly selected isolation devices, or other faults in the system that could affect the performance of the system. Developer Design/Builder shall submit a report to the County's Representative, including the manufacturer's representative's final report indicating all isolation reported as properly installed or requiring correction, and include a report by the Developer Design/Builder on steps taken to properly complete the isolation work.
- B. All seismic restraints must be installed and adjusted so that the equipment and piping vibration isolation is not degraded by utilization of the restraints.

3.06 PIPING ISOLATOR, VERTICAL RISER OR HORIZONTALLY SUPPORTED

- A. The objective and installation procedure is similar to the equipment isolator installation procedures inside chiller rooms, boiler rooms, fan rooms, mechanical room and plumbing equipment rooms.
- B. Riser support for pumped piping 4 inches and larger shall be 1.0 inch deflection, Type MSL. Riser guide shall be Type PGA.
- C. Horizontal roof supported for condenser water piping shall be 1.0 inch deflection, Type MSL.

3.07 PIPING ISOLATOR, HORIZONTALLY SUSPENDED PIPING

- A. The isolators shall be installed with the isolator hanger box as close as possible to the structure.
- B. The isolators shall be provided in accordance with the Acoustics and Sound Criteria, see Volume II – Book 1.
- C. Hanger rods shall be aligned to clear the hanger box.
- D. Pumped piping inside chiller room, boiler room, fan room and plumbing equipment room and up to 50 feet from pumps shall be provided with vibration isolators Type HS with 1 inch deflection.

3.08 DUCTWORK

- A. Flexible connections shall be incorporated in the ductwork adjacent to all air moving units supported with isolators. Connections shall be as herein specified.

3.09 INSTALLATION OF SEISMIC RESTRAINT

- A. All seismic restraints must be installed and adjusted so that the equipment and piping vibration isolation is not degraded by utilization of the restraints.

- B. Equipment:
 - 1. Position all seismic restraints with equipment in operation for proper operating clearances.
 - 2. Weld or bolt seismic restraints to seismic anchor plate.
- C. Piping:
- D. Installation of Flexible Pipe Connectors: Install flexible pipe connectors at pump's suction and discharge sides and elsewhere as required. Install flexible pipe connectors in accordance with manufacturer's written instructions.
- E. Seismic support spacing shall be in accordance to Manufacturers Pre-Approved system.
- F. Developer Design/Builder to install at each seismic brace location a permanent identification tag dictating the following information:
 - 1. Contractor's name.
 - 2. Location identification number
 - 3. Horizontal "g" force
 - 4. Maximum weight of suspended utility
 - 5. Maximum brace reaction
- G. Upon installation of seismic bracing for vibration isolated and rigidly supported items Manufacturer Representative to provide documentation of proper installation according to pre-submitted Developer Design/Builder seismic layout detail.

3.10 FIELD QUALITY CONTROL

- A. Division 01 - Quality Requirements and Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect isolated equipment after installation and submit report. Include static deflections.
- C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.
- D. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

END OF SECTION