

SECTION 23 05 41
NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

SPEC WRITER NOTES:

1. Use this section only for NCA projects.
2. Delete between // // if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs.
3. Coordinate VA standard details with this spec Section and show details on H drawings as applicable:
 - a. 23 05 41-01 Vibration Isolation Bases
 - b. 23 05 41-02 Thrust Restraint for Fans
 - c. 23 05 31-03 Concrete Equipment Bases
 - d. 23 05 41-05 Securing Hanger Rods in Concrete

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Noise criteria, //seismic restraints for equipment, // vibration tolerance, and vibration isolation for HVAC work.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.2 RELATED WORK

SPEC WRITER NOTE: Retain one of two paragraphs below.

- A. //Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects).//
- B. //Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects).//
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- D. Section 01 42 19, REFERENCE STANDARDS.
- E. Section 01 81 13, SUSTAINABLE DESIGN REQUIREMENTS.
- F. //Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.//
- G. //Section 03 30 53, (Short-Form) CAST-IN-PLACE CONCRETE: Requirements for concrete inertia bases.//

SPEC WRITER NOTE: If Section 13 05 41 is included in this project the section shall be obtained from VA Masters.

- H. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.//

- I. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items which are common to more than one section of Division 23.
- J. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: requirements for sound and vibration tests.
- K. //Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//
- L. Section 23 31 00, HVAC DUCTS AND CASINGS: requirements for flexible duct connectors, //sound attenuators,// and sound absorbing duct lining.

1.3 APPLICABLE PUBLICATIONS

SPEC WRITER NOTE: Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project, unless the reference applies to all mechanical systems. Publications that apply to all mechanical systems may not be specifically referenced in the body of the specification, but, shall form a part of this specification.

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 Latest Edition.....ASHRAE Handbook-HVAC Applications, Noise and Vibration Control Chapter
- C. American Society for Testing and Materials (ASTM):
 A123/A123M-2015.....Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 A307-2014.....Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
 D2240-2005 (R2010).....Standard Test Method for Rubber Property - Durometer Hardness
- D. U.S. Department of Veterans Affairs (VA):
 H-18-8-2013.....Seismic Design Requirements

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Vibration isolators:
 - a. Floor mountings
 - b. Hangers
 - c. Snubbers
 - d. Thrust restraints
 - 2. Bases.
 - 3. //Seismic restraint provisions and bolting.//
 - 4. Acoustical enclosures.
- D. Furnish load calculations from manufacturer for selected isolators, including supplemental bases, based on lowest operating speed of equipment supported.
- E. //Seismic Requirements: Submittals are required for all equipment anchors, supports, and seismic restraints. Include weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic Lateral Force requirements as shown on drawings.//
- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. //Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician

and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

- H. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

1.5 QUALITY ASSURANCE

SPEC WRITER NOTE: The designer is responsible for evaluating and controlling equipment noise and shall select equipment, specify sound ratings, and provide attenuators so that noise criteria listed below, local noise ordinance levels, and OSHA requirements will not be exceeded. Unattainable noise criteria levels may be increased for rooms with self-contained cooling units.

- A. Refer to paragraph QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

SPEC WRITER NOTE: Edit list of rooms and NC levels to suit specific project being designed. Add rooms and NC levels if required.

- B. Noise Criteria:

1. Do not exceed the NC levels listed below for noise levels in all 8 octave bands due to equipment and duct systems:

Type of Room	NC LEVEL
Bathrooms and Toilet Rooms	30
Chapels	25
Conference Rooms	30
Corridors(Public)	40
Lobbies, Waiting Areas	40
Locker Rooms	50
Offices, large open (3 or more occupants)	40
Offices, small private (2 or fewer occupants)	30
Maintenance	50

2. For equipment which has no sound power ratings scheduled on the plans, select equipment such that the foregoing noise criteria, local ordinance noise levels, and OSHA requirements are not

- exceeded. Use selection procedure in accordance with ASHRAE Handbook-HVAC Applications, Noise and Vibration Control Chapter.
3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy.
 4. In absence of specified measurement requirements, measure equipment noise levels 3 feet from equipment, and at an elevation of maximum noise generation.
- C. See Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC for requirements for sound and vibration tests.
- D. //Seismic Restraint Requirements:
- SPEC WRITER NOTE: Brace equipment in regions of Moderate-High, High, and Very High Seismicity, and piping and ductwork in Regions of High and Very High Seismicity. Regions of Seismicity in VA shall be obtained from the latest VA Handbook H-18-8, "Seismic Design Requirements".
1. Equipment:
 - a. Securely anchor to the structure all mechanical equipment not supported with isolators external to the unit. Properly support such mechanical equipment to resist a horizontal force of //50// //20// percent of the weight of the equipment furnished.
 - b. Provide with seismic restraints, capable of resisting a horizontal force of //100// //50// percent of the weight of the equipment furnished, all mechanical equipment mounted on vibration isolators.
 2. Piping: Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
 3. Ductwork: Refer to specification Section 23 31 00, HVAC DUCTS AND CASINGS.//
- E. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (3/16 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal, and axial directions, or measured at equipment mounting feet if

bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

1.6 AS-BUILT DOCUMENTATION

SPEC WRITER NOTE: Coordinate O&M Manual requirements with Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects) or Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects). O&M manuals shall be submitted for content review as part of the close-out documents.

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be //in electronic version on CD or DVD// inserted into a three ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version //____// provided on CD or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

PART 2 - PRODUCTS**2.1 GENERAL REQUIREMENTS**

- A. Ensure the type of isolator, base, and minimum static deflection meet the requirements of each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.
- B. Ensure elastomeric isolators comply with ASTM D2240 and be oil resistant neoprene, with a maximum stiffness of 60 durometer, and have a straight-line deflection curve.

SPEC WRITERS NOTE: Show wind velocity
from VA Natural Disasters Resistive
Design (CD-54) for hurricane areas.

- C. Exposure to Weather: Ensure isolators, including springs exposed to weather, have been hot dip galvanized after fabrication. Ensure hot-dip zinc coating be not less than 609 grams/m² (2 ounces/sf) by weight, complying with ASTM A123/A123M. In addition, provide limit stops to resist wind velocity. Comply with the design wind velocity of // // kmph (// // mph).
- D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even if equipment weight is not evenly distributed.
- E. Color code isolators by type and size for easy identification of capacity.

2.2 //SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENT

- A. Bolt pad mounted equipment, without vibration isolators, to the floor or other support using ASTM A307 standard bolting material.
- B. Floor mounted equipment, with vibration Isolators: Type SS. Where Type N isolators are used, provide channel frame base horizontal restraints bolted to the floor, or other support, on all sides of the equipment. Ensure size and material required for the base be as recommended by the isolator manufacturer.
- C. On all sides of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment. The slack cable restraint method, by Mason Industries, or VA approved equal, is acceptable.//

2.3 VIBRATION ISOLATORS

A. Floor Mountings:

1. Double Deflection Neoprene (Type N): Includes neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.

SPEC WRITER NOTE: For projects in VA Seismic areas delete Types S, D, W and L. For non-seismic areas delete Types SS and snubbers.

2. Spring Isolators (Type S): Free-standing, laterally stable, including acoustical friction pads and leveling bolts. Ensure isolators have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
3. //Captive Spring Mount for Seismic Restraint (Type SS):
 - a. Design mounts to resiliently resist seismic forces in all directions. Ensure snubbing to take place in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum of 6 mm (1/4 inch) before contacting snubbers. Ensure mountings have a minimum rating as to be able to withstand the force associated with 1 g of acceleration as calculated and certified by a registered structural engineer.
 - b. Ensure all mountings have leveling bolts rigidly bolted to the equipment. Ensure spring diameters be no less than 0.8 of the compressed height of the spring at rated load. Ensure springs have a minimum additional travel to solid equal to 50 percent of the rated deflection. Ensure mountings have ports for spring inspection. Provide an all directional neoprene cushion collar around the equipment bolt.//
4. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind loads. Provide clearance around restraining bolts as to prevent mechanical short circuiting. //Ensure isolators have a minimum seismic rating as to withstand spectral acceleration of 1 g.//
5. Pads (Type D), Washers (Type W), and Bushings (Type L): Ensure pads are made of felt, cork, neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced

- duck and neoprene. Ensure washers and bushings are made of reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 psig).
- B. Hangers: Combination neoprene and springs unless otherwise noted and allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Ensure vibration hangers contain a spring and double deflection neoprene element in series. Ensure springs have a diameter of not less than 0.8 of compressed operating spring height. Ensure springs have a minimum additional travel of 50 percent between design height and solid height. Ensure springs permit a 15-degree angular misalignment without rubbing on hanger box.
 2. Ensure hanger supports for piping 50 mm (2 inches) and larger have a pointer and scale deflection indicator.
- C. Snubbers: Ensure each spring mounted base has a minimum of 4 all-directional or 8 two-directional (2 per side) seismic snubbers that are double acting. Ensure elastomeric materials are shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable, and have a minimum thickness of 6 mm (1/4 inch). Ensure air gap between hard and resilient material be not less than 3.2 mm (1/8 inch) nor more than 6 mm (1/4 inch). Ensure restraints are capable of withstanding design load without permanent deformation.

2.4 BASES

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, ensure height of members are a minimum of 1/12 of longest base dimension, but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.
- B. Inertia Base (Type I): Ensure base to be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating pre-located equipment anchor bolts and pipe sleeves. Level the concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Ensure channel depth be a minimum of 1/12 of longest dimension of base but not less than 150 mm (6 inches). Ensure form to include 15 mm (1/2 inch) reinforcing bars welded in place, minimum of 200 mm (8 inch) on center, running both

ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Ensure weight of inertia base be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16 inch).

- C. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb, with overlap to allow water run-off, and having wind and water seals which do not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Ensure top and bottom bearing surfaces have sponge type weather seals. Ensure integral spring isolators comply with Spring Isolator (Type S) requirements.

2.5 SOUND ATTENUATING UNITS

- A. Refer to specification Section 23 31 00, HVAC DUCTS AND CASINGS.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. Vibration Isolation:
1. No metal-to-metal contact will be permitted between fixed and floating parts.
 2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Ensure electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.), which rests on vibration isolators, be isolated from building structure for first 3 hangers or supports.
 3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Ensure bases are level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
 4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
 5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Ensure pipe elbow supports do not short-circuit pump vibration to structure.

6. Ensure non-rotating equipment, such as heat exchangers and convertors, are mounted on isolation units having the same static deflection as the connected piping support system.

C. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

3.2 ADJUSTING

- A. Adjust vibration isolators after piping systems are filled and equipment 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 and at shutdown state.
- C. Attach thrust limits at centerline of thrust, and adjust to a maximum of 6 mm (1/4 inch) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- G. //Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.//

3.3 STARTUP AND TESTING

- A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. //The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.//

3.4 //COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- B. Components provided under this section of the specification will be tested as part of a larger system.//

3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for //four// // // hour//s// to instruct each VA personnel responsible in the operation and maintenance of units.
- B. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

- - - E N D - - -

SELECTION GUIDE FOR VIBRATION ISOLATORS

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN			
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	
REFRIGERATION MACHINES																
PACKAGED	---	D	0.25	---	SP	1.5	---	SP	1.5	---	SP	2.5	R	SP	2.5	
COMPRESSORS																
UP THROUGH 1-1/2 HP	---	D,L,W	0.25	---	SS	0.8	---	SS	1.5	---	SS	1.5	CB	SS	1.5	
2 HP AND OVER:																
500 - 750 RPM	---	D	0.25	---	SS	0.8	---	SS	1.5	---	SS	1.5	CB	SS	1.5	
750 RPM & OVER	---	D	0.25	---	SS	0.8	---	SS	1.5	---	SS	1.5	CB	SS	1.5	
PUMPS																
BASE MOUNTED	UP TO 10 HP	I	S	0.75	I	S	0.75	I	S	1.5	I	S	1.5	I	S	1.5
	15 HP THRU 40 HP	I	S	0.75	I	S	0.75	I	S	1.5	I	S	1.5	I	S	1.5
IN-LINE	UP TO 25 HP	---	S	0.75	---	S	1.5	---	S	1.5	---	S	1.5	---	S	1.5
ROOF VENTILATORS																
ABOVE OCCUPIED AREAS:																
UP TO 22" DIAMETER	---	---	---	---	S	0.75	---	S	0.75	CB	S	0.75	CB	S	0.75	
AIR HANDLING UNIT PACKAGES																
SUSPENDED:																
UP THRU 10 HP	---	S	0.75	---	H	0.75	---	H	0.75	---	H	0.75	---	H	0.75	
15 HP & OVER:																

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
UP TO 300 RPM	---	---	---	---	H	3.5	---	H	3.5	---	H	3.5	---	H	3.5
301 RPM & OVER	---	---	---	---	H	2.5	---	H	2.5	---	H	2.5	---	H	2.5
FLOOR MOUNTED:															
UP THRU 5 HP	---	S	0.75	---	S	3.5	---	S	3.5	---	S	3.5	---	S	3.5
7-1/2 HP & OVER:															
UP TO 300 RPM	---	S	0.75	---	S	3.5	---	S	3.5	CB	S	3.5	CB	S	3.5
301 RPM & OVER	---	S	0.75	---	S	2.5	---	S	2.5	CB	S	2.5	CB	S	2.5

NOTES:

1. Edit the Table above to suit where isolator, other than those shown, are used, such as for seismic restraints and position limit stops.
2. For suspended floors lighter than 100 mm (4 inch) thick concrete, select deflection requirements from next higher span.
3. For projects in seismic areas, use only SS & DS type isolators and snubbers.
4. For floor mounted in-line centrifugal blowers (ARR 1): use "B" type in lieu of "R" type base.
5. Suspended: Use "H" isolators of same deflection as floor mounted.