SECTION 23 05 48
VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 ADDITIONAL RELATED DOCUMENTS

A. Related Division 23 Sections include the following:

1. "Hangers and Supports for HVAC Piping and Equipment" for pipe hanger restraints.
2. "Ductwork" for hanger materials for ductwork.
3. "Air Duct Accessories" for flexible duct connectors.
4. "Common Work Results for HVAC" for flexible pipe connectors.
5. Various Division 23 equipment specification sections for equipment requiring factory-furnished internal vibration isolation.

1.3 SUMMARY

A. This Section includes vibration isolators, thrust restraints, vibration isolation bases, and delegated design and engineering.

1.4 ACTION SUBMITTALS

A. Product Data: Indicate types, styles, materials, and finishes for each type of isolator specified. Include load - deflection curves.

B. Shop Drawings and Delegated Design: The Division 23 Contractor shall provide designs and calculations, certified by a professional engineer, for the following:

1. Vibration Isolation Design Calculations: Calculations for selection of vibration isolators and design of vibration isolation bases, hangers, and supports. Exception: Rotating equipment vibration isolation products not subject to wind loads that are provided as part of factory-engineered equipment packages.

C. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.

D. Vibration Isolation Spring Rail Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include spring rail weights.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For the professional engineer providing the delegated design services and for the testing agency.

1.6 QUALITY ASSURANCE

A. Delegated Design and Engineering Responsibility: The Division 23 Contractor is responsible for the delegated design and engineering provisions of this Section.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in Pennsylvania and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases, hangers, and supports that are similar to those indicated for this Project in material, design, and extent.

a. The professional engineer providing these design services shall be the same individual providing calculations and design in accordance with the delegated design requirements of Division 23 Sections "Hangers and Supports for HVAC Piping and Equipment" and “Expansion Loops for HVAC Piping”. Refer to the Quality Assurance articles in these Sections for additional qualification requirements.
b. The professional engineer may be an employee of the Division 23 Contractor, the vibration isolation manufacturer, or another company.

1.7 COORDINATION

A. Coordinate layout and installation of vibration isolation devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of concrete housekeeping and vibration isolation bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.

C. Coordinate installation of equipment supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Vibration Isolation Products:

a. BRD Noise and Vibration Control Inc.
b. Kinetics Noise Control Inc.

c. Mason Industries, Inc.
d. Novia Associates Inc.; a Div. of C&P
e. The VMC Group
f. Vibration Eliminator Co., Inc.
g. Vibro-Acoustics; a Div. of the Swegon Group
h. Or equal as approved by the Professional.

2.2 VIBRATION ISOLATORS

A. Isolator Pads: Oil and water resistant and factory cut to sizes that match requirements of the equipment supported.

1. Rubber Isolator Pads: Elastomer (neoprene or silicone) arranged in single or multiple layers and molded with a nonslip ribbed or waffle pattern and with steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
2. Load Range: From 10 to 50 psig and a deflection not less than 0.08 inch per 1 inch of thickness. Do not exceed a loading of 50 psig.

B. Spring Isolators: Freestanding, laterally stable, open-spring-type isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 0.75 times the rated vertical stiffness. The spring diameter shall be no less than 0.8 of the compressed height of the spring at rated load.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to a 1/4-inch-thick, rubber isolator pad attached to the baseplate underside. Size baseplates to limit floor loading to 500 psig.
6. Top Plates: Provide threaded studs for fastening and leveling equipment.
7. Finishes: Baked enamel for metal components on isolators for interior use.

C. Restrained Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring-type isolators.

1. Housing: Welded steel with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Factory-drilled baseplate for bolting to structure and bonded to a 1/4-inch-thick, rubber isolator pad attached to the baseplate underside. Provide adjustable equipment mounting and leveling bolt.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 0.75 times the rated vertical stiffness. The spring diameter shall be no less than 0.8 of the compressed height of the spring at rated load.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Finishes: Baked enamel for metal components on isolators for interior use.

D. Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.

1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
6. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
7. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.
8. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

E. Thrust Limits (Restraints): Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.3 INDOOR VIBRATION ISOLATION EQUIPMENT BASES

A. Fabricated Steel Bases: Structural-steel bases and rails designed and fabricated by the isolation equipment manufacturer. Include equipment static loadings, power transmission, component misalignment, and cantilever loadings.

1. Fabricate bases to shapes required, with welded structural-steel shapes, plates, and bars conforming to ASTM A 36. Include support brackets to anchor base to isolation units. Include pre-located equipment anchor bolts and auxiliary motor slide bases or rails.
2. Design and fabricate bases to result in the lowest possible mounting height with not less than 1-inch clearance above the floor.
3. Weld steel angles on frame for outrigger isolation mountings, and provide for anchor bolts and equipment support.
4. Factory Finish: Manufacturer's standard corrosive-resistant finish.

2.4 LIGHT DUTY RESTRAINED ISOLATION SPRING RAILS

A. Construction: The isolation system shall consist of two (2) independent isolation spring rails. Each spring rail shall consist of vibration isolation set beneath steel rails. The support rails shall be galvanized steel channels with a minimum of two (2) all-directional restraints per rail and factory located adjustable springs as required for dead loads.

B. Isolation: Static deflection shall be minimum 2", or as indicated on the Drawings, whichever is greater. Vibration isolators shall be free standing, laterally stable springs wound from high strength spring steel set in a zinc plated steel housing. Springs shall have a lateral stiffness greater than 1.1 times the rated vertical stiffness under rated load and deflection. Springs shall be designed to retain a minimum of 0.75 inch travel beyond the rated capacity to accommodate overloads. Housing assembly shall be a steel member that includes provisions for attachment to the support rail or pad. It shall interface with a coil spring leveling assembly and a 3-axis restraint snubbing element that shall bolt directly to the underside of the equipment support rail. The housing shall be fitted with integral non-skid isolation pads and holes for anchoring the housing to the supporting structure. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. Springs shall be factory powder-coated.

C. Basis of Design: Kinetics Noise Control, Inc. - "LDR".

1. Subject to compliance with requirements, the Contractor may provide equal products by the manufacturers listed in Article 2.1 of this Section.

2.5 HEAVY DUTY RESTRAINED ISOLATION SPRING RAILS

A. Construction: Spring rails shall consist of an integrated, low profile assembly consisting of vibration isolation between upper and lower steel rails forming a structural base. Support rails shall be structural channel and angle sections with a minimum of two (2) all-directional restraints per rail and factory located adjustable springs as required for dead loads. Support rails shall be cross braced at all restraint locations with structural angle sections to provide a rigid, distortion-free common frame to support and anchor separate equipment components or driven members. Support rails shall be factory drilled to match equipment mounting provisions, have pre-located and drilled bolt/anchor holes or brackets at each restraint location, and shall be designed and supplied by the isolation materials manufacturer. Rails shall be hot dipped galvanized.

B. Isolation: Static deflection shall be minimum 2", or as indicated on the Drawings, whichever is greater. Vibration isolators shall be free standing, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness under rated load and deflection. Springs shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 0.25" thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. Springs shall be replaceable. Springs shall be factory powder-coated.

C. Basis of Design: Kinetics Noise Control, Inc. - "QuietRail"

1. Subject to compliance with requirements, the Contractor may provide equal products by the manufacturers listed in Article 2.1 of this Section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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.

3.2 APPLICATIONS AND INSTALLATION

A. General: Except as otherwise indicated*, select vibration control products in accordance with ASHRAE Handbook, 2015 Edition of HVAC Applications Volume, Chapter 48 "Noise and Vibration Control", including Table 47. Where more than one type of product is recommended in Table 47, the selection is the Contractor's option so long as that type of product is specified in this Section.

1. Exceptions:

   a. Type 3 (spring) hangers and mounts shall be used where Type 2 (rubber) hangers and mounts are indicated in Table 47.
   b. Steel frame bases may be provided in lieu of concrete inertia bases for base mounted fans where the fan is controlled by a variable frequency drive.
   c. *Specific indications on the Drawings or in an equipment specification Section elsewhere in Division 23 shall take precedence over the above referenced chapter of the ASHRAE HVAC Applications Handbook.

B. All rotating, vibrating, and motor driven equipment shall be provided with field applied vibration isolation from one of the manufacturers listed elsewhere in this Section, except the following:

1. Base mounted pumps bearing on slabs on grade, except where indicated on the Drawings.
2. Pipeline mounted pumps with motor sizes less than 3HP.
3. Where internal isolation has been provided as part of the factory-manufactured equipment package, except for equipment where spring rails have been specified. The isolator products used shall comply with this Section, and other specific indications in the Contract Documents, including type and minimum amount of static deflection.

C. Light Duty Restrained Isolation Spring Rails: Provide for equipment as indicated on the Drawings. If the weight of the supplied equipment exceeds the limits recommended by the manufacturer for light duty spring rails, provide heavy duty spring rails, Kinetics "QuietRail', or approved equal.

1. Internal isolators that are factory-provided with rooftop equipment, other than rubber-in-shear or rubber pad isolators with less than 1/3" static deflection, shall either be omitted or “locked out” to prevent the possibility of resonance with the spring rails.

D. Heavy Duty Restrained Isolation Spring Rails: Provide for equipment as indicated on the Drawings.

1. Internal isolators that are factory-provided with rooftop equipment, other than rubber-in-shear or rubber pad isolators with less than 1/3" static deflection, shall either be omitted or “locked out” to prevent the possibility of resonance with the spring rails.

E. Install and anchor vibration-control products according to manufacturer's written instructions and authorities having jurisdiction.

F. Anchor interior mounts, isolators, and hangers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.

G. Installation of vibration isolators shall not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

H. Equipment isolators and bases shall be dedicated to a single piece of vibrating equipment.

I. No rigid connections or contact between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified. Coordinate work with other trades to avoid rigid contact with the building elements or the work of other trades.

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

K. Provide flexible duct connectors on duct connections to fan-containing equipment as specified in Division 23 Section "Air Duct Accessories".

L. Thrust Restraints: Provide thrust limits (restraints), in one or more pairs, on all fans operating in excess of 4-inch w.g. total static pressure, where flexible duct connectors have lost slack due to fan movement, or where the fan movement relative to the ductwork exceeds 3/4-inch.

1. Thrust restraints shall rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Adjust to a maximum of 1/4-inch movement during start and stop of fans.

M. Fill concrete inertia bases, after installing base frame, with 3000-psig concrete, and trowel to a smooth, hard finish. Cast-in-place concrete is specified in Division 03.

N. Piping and Ductwork: Combination rubber and spring vibration isolation shall be provided for piping and ductwork as follows:

1. Ductwork: Isolation shall be provided for the first 15 feet from the equipment, down all duct paths. Isolators shall have no less than 3/4" static deflection.
2. Piping: The first three (3) pipe hangers adjacent to vibration isolated equipment. Pipe hanger isolators shall have the same deflection as that supplied for equipment to which the piping is attached.

    a. The vibration isolator units selected shall not deter the thermal movement of the piping or prevent expansion loops or joints from performing their required task.
    b. Install flexible pipe connectors or flexible piping hoses at connections for equipment supported on vibration isolators. Refer to Division 23 Sections "Common Work Results for HVAC" and "Hydronic Piping".

3. As further indicated on the Drawings.

3.3 ADJUSTING

A. 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 operations.

B. Adjust thrust restraints for a maximum of 1/4 inch of movement at start and stop. Perform adjustments with the fans operating at the maximum anticipated system operating pressures.

END OF SECTION