

SECTION 23 0550 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Vibration Isolation Mounts and Hangers
    - a. Isolation pads.
    - b. Isolation mounts.
    - c. Restrained elastomeric isolation mounts.
    - d. Restrained spring isolators.
    - e. Elastomeric hangers.
    - f. Spring hangers.
    - g. Spring hangers with vertical-limit stops.
  - 2. Vibration Isolation Equipment Bases
    - a. Structural Steel Frame Inertia Bases
    - b. Concrete Inertia Bases
  - 3. Rooftop Equipment Vibration Isolation
    - a. Curb-Mounted Fiberglass Strips
    - b. Curb-Mounted Spring Rail
    - c. Sheet Metal Restraint / Spring Isolation Curbs.
  - 4. Acoustical Pipe Seals
  - 5. All-Directional Acoustical Pipe Anchors.
  - 6. Telescoping Type Vertical Sliding Guides.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. ASCE-7, Minimum Design Loads for Buildings and Other Structures
- D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

- E. American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)
- F. The Vibration Isolation and Seismic Control Manufacturers Association (VISCMA)

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
  - 1. For Basic Wind Speed and Building Classification Category, please refer to the project Structural Drawings.
  - 2. Project design value in lb/sq. ft. (kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

#### 1.5 ACTION SUBMITTALS

- A. All vibration isolation products and wind restraints must be by a single manufacturer.
- B. Product Data: For the following:
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. 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 member of ICC-ES or an agency acceptable to authorities having jurisdiction.
    - b. Annotate to indicate application of each product submitted and compliance with requirements.
  - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- C. Delegated-Design Submittal: For vibration isolation and restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, and wind forces required to select vibration isolators, and wind restraints, and for designing vibration isolation bases.
    - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
  - 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
  - 3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Wind Restraint Details:

- a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
- b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.
- c. Coordinate restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
- d. Pre-approval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of required clearances and bracing for HVAC duct and equipment with other systems and equipment in the vicinity, including other supports, wind restraints, housekeeping pads, and roof curbs.
- B. Qualification Data: For professional engineer, manufacturer, installer, and testing agency.
- C. Welding certificates.
- D. Field quality-control test reports.

1.7 FIELD MEASURE

- A. Verify field measurements prior to fabrication.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with wind design/restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 General

- A. Metal parts of vibration isolation units installed out-of-doors shall be hot-dipped galvanized, cadmium-plated, or Neoprene-coated after fabrication. Galvanizing shall meet ASTM 44 "Salt Spray Test Standards and Federal Test Standard."
- B. Spring elements shall be powder coated and tested in salt spray fog test per ASTM B117 standards
- C. Spring elements shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity before solid state is reached. Spring shall be safe at solid state.
- D. Spring elements shall be color coded or otherwise identified to indicate load capacity.
- E. Isolator types are scheduled to establish minimum standards. Optionally, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation, and initial system filling operations, and similar installation advantages. Accessories shall not degrade vibration isolation systems.
- F. Vibration Isolators shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the vibration isolation schedule listed in this specification.
- G. Refer to schedules on drawings covering devices specified herein.

2.2 VIBRATION ISOLATION MOUNTS AND HANGERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amber Booth Company.
  - 2. Kinetics Noise Control.
  - 3. Mason Industries.
  - 4. Vibration Mountings and Controls, Inc.
  - 5. Vibro-Acoustics.
- B. Pads <TYPE 1>: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment. Minimum static deflection .25"
  - 1. Resilient Material: Oil- and water-resistant neoprene, rubber, or hermetically sealed compressed fiberglass.
- C. Mounts <TYPE 2>: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range. Minimum static deflection .25"

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- D. Restrained Spring Isolators <**Type 3**>: Freestanding, steel, housed (Type C mounting), isolators with limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Housing shall be designed to resist all wind forces as applicable per building codes.
  2. Restraint: Limit stop as required for equipment and authorities having jurisdiction. Restraining bolts shall have a neoprene bushing between the bolt and the housing. Limit stops shall be out of contact during normal operation.
  3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- E. Elastomeric Hangers <**Type 4**>: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- F. Spring Hangers <**Type 5**>: Combination coil-spring and fiberglass-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 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. 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. Fiberglass Element: Molded, oil-resistant fiberglass. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- G. Spring Hangers with Vertical-Limit Stop <**Type 6**>: Combination coil-spring and fiberglass-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 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. 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. Fiberglass Element: Molded, oil-resistant fiberglass.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

### 2.3 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Amber Booth Company.
  2. Kinetics Noise Control.
  3. Mason Industries.
  4. Vibration Mountings & Controls, Inc.
  5. Vibro-Acoustics.
  
- B. Steel Base <Type A>: Factory-fabricated, welded, structural-steel bases and rails.
  1. Design Requirements: Lowest possible mounting height with not less than a 2-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
  2. Include supports for suction and discharge elbows for pumps.
  3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  5. All vibration isolated structural frame base equipment shall have flexible connectors on all attached piping, duct, conduit, etc. as to fully isolate the unit.
  
- C. Inertia Base <Type B>: Factory-fabricated, welded, structural-steel bases and rails including placement of cast-in-place concrete.
  1. Design Requirements: Lowest possible mounting height with not less than a 2-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
  2. Include supports for suction and discharge elbows for pumps.
  3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  4. Support Brackets: Factory-welded steel brackets on frame for isolation mountings and to provide for anchor bolts and equipment support.
  5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
  6. All vibration isolated concrete inertia base equipment shall have flexible connectors on all attached piping, duct, conduit, etc as to fully isolate the unit.
  7. Cast-In-Place Concrete: Fill base with concrete per bas manufacturer's instructions, using concrete meeting concrete specs.

## 2.4 ROOFTOP EQUIPMENT VIBRATION ISOLATION &lt;Type C&gt;

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control.
  2. Mason Industries.
  3. Thybar Corporation.
  4. Vibration Eliminator Co., Inc.
  5. 5. Vibration Mountings & Controls, Inc.
- B. General Requirements
1. Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand project wind forces.
  2. All components within the final product and including the final product are to be manufactured within the United States of America.
  3. Complete curb and isolation assembly shall be stamped by a Professional Engineer licensed in the jurisdiction of the project.
  4. Provide sloped and/or extended height curb assemblies as necessary to coordinate with roof slope and buildup.
  5. All vibration isolated structural frame base equipment shall have flexible connectors on all attached piping, duct, conduit, etc. as to fully isolate the unit.
- C. Curb-Mounted Fiberglass Strips <Type D-1>
1. Fiberglass continuous support material shall be high-density matrix of compressed molded fiberglass; individually coated with a flexible moisture-impervious elastomeric membrane.
  2. Material is to be non-corrosive, non-combustible, non-absorbent, and resists rust, ozone, mildew, and fungus.
  3. Material will not shrink, swell, or decompose.
  4. Isolation characteristics of the media are to remain constant over a temperature range of -40F to 250F.
- D. Curb Mounted Spring Rail <Type D-2>
1. Full-perimeter rail type isolator, spring components shall be 1" or 2" deflection, free-standing, un-housed, laterally stable steel spring. Springs have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed for 50% overload to solid.
  2. Rails shall provide continuous support for the rooftop equipment and shall consist of extruded aluminum top and bottom members connected by spring isolators and a continuous air and water-tight seal.
  3. Curb Mounted Spring Rail is mounted on existing roof curb or curbs provided by others.
- E. Sheet Metal Restraint / Spring Isolation Curbs <Type D-3>
1. Lower Support Assembly: Formed sheet-metal section containing steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.

2. Spring Isolators: restrained spring isolators shall be mounted on 1/4-inch- (6-mm-) thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
  - a. Restrained Spring Isolators: Steel, open-spring isolators with wind restraint.
    - 1) Housing: Steel with resilient vertical-limit stops and 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 80 percent of rated vertical stiffness.
    - 5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - b. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
    - 1) Resilient Material: Oil- and water-resistant standard neoprene, natural rubber, or hermetically sealed compressed fiberglass.
3. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.
4. Water Seal: EPDM or Galvanized sheet metal weather seal attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

## 2.5 ACOUSTICAL PIPE SEALS

- A. Split seals shall consist of pipe halves with minimum 3/4" thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed in around the seal to make it integral with the floor, wall, or ceiling if the seal is not in place prior to the construction of the building surface or member.
- B. Seals shall project a minimum of 1" past either face of walls. Where temperatures exceed 240°F, 10 pound density fiberglass may be used in lieu of the sponge.
- C. Seals shall be Type SWS by Mason Industries or approved equal.

## 2.6 TELESCOPING TYPE VERTICAL SLIDING GUIDES

- A. Guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum of 1/2" thickness of 60 durometer or softer neoprene. The height of the guides shall be preset with a set screw/bolt to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of +/- 1.625" motion, or to meet location requirements.
- B. Guides shall be Type VSG by Mason Industries or approved equal.



2.7 ALL DIRECTIONAL ACOUSTICAL PIPE ANCHORS

- A. Guides shall consist of f two sizes of steel tubing separated by a minimum of 1/2" thickness of 60 durometer or softer neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
- B. Guides shall be Type ADA by Mason Industries or approved equal.

2.8 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
  - 1. Powder coating on springs and housings.
  - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
  - 3. Baked enamel or powder coat for metal components on isolators for interior use.
  - 4. Color-code or otherwise mark vibration isolation and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation 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.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
- 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. All rotating equipment shall have vibration isolation from building structure.
- D. Ducts within 50' of fan discharges shall be isolated by spring hangers with neoprene cups.

- E. The first three hangers and floor supports from equipment (i.e. pumps, etc.) shall be isolated by spring hangers with neoprene cup for pipe and spring isolated concrete inertia base mounts respectively.
- F. Pipes passing through equipment room walls, floors, or ceilings shall have all directional acoustical pipe seals.
- G. Pipe risers shall be suspended from or supported by all directional acoustical pipe anchors and telescoping type guides.
- H. All supply fans and pumps are to have at least four isolation springs located at the corners of the equipment.

### 3.3 VIBRATION-CONTROL AND RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
- C. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports and brace change of direction following SMACNA and VISCMA recommendations per a professional engineer.
- D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- E. 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.
- F. 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.
- G. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed 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.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: The Owner shall engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. Measure isolator restraint clearance.
  7. Measure isolator deflection.
  8. Verify snubber minimum clearances.
  9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

### 3.5 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 active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

### 3.6 DEMONSTRATION

- A. Refer to Division 01 Section covering demonstration and training.

NORTHWESTERN UNIVERSITY

PROJECT NAME \_\_\_\_\_

JOB # \_\_\_\_\_

FOR: \_\_\_\_\_

ISSUED: 03/29/2017

3.7 HVAC VIBRATION-CONTROL AND RESTRAINT DEVICE SCHEDULE AND SUPPLY FAN AND HVAC PUMP APPLICATION

- A. See drawing schedules but, the minimum mounting deflection for spring isolators shall be as follows: 300 rpm, 3.5"; 500 rpm, 1.65"; 800 rpm, 1.00"; 1200 rpm and higher, 0.80".
- B. All supply fans and HVAC pumps are to have at least (4) spring isolators located at the corners of the fans/pumps.

**END OF SECTION 23 0550**