

SECTION 230548 – VIBRATION AND SEISMIC CONTROLS FOR HVAC SYSTEMS

First Edition 5-16-2017

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specification and adding any additional specifications that may be required by the project. Also turn off all “Underlines”.)

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 and all other sections of Division 23.

1.2 SUMMARY

- A. This section includes the requirements for vibration and seismic control using the following: **<Edit for project>**
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Open-spring isolators.
 - 4. Pipe-riser resilient supports.
 - 5. Resilient pipe guides.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.
 - 8. Equipment bases.
 - 9. Restraint channel bracing.
 - 10. Restraint cables.
 - 11. Resilient lateral guides.
 - 12. Seismic-restraint accessories.
 - 13. Mechanical anchor bolts.
 - 14. Adhesive anchor bolts.

1.3 ACTION SUBMITTALS

- A. Product Data for Each Type of product.
 - 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 vibration isolation device and seismic-restraint component required.
 - 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] [OSHPD] [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.
- B. Shop Drawings: Shop Drawings shall include the following information:
 1. Detail fabrication and assembly of equipment bases.
 2. Detail fabrication including anchorages and attachments to structure and to supported equipment.
- C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
 1. Include design calculations and details for selecting vibration isolators, seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
 3. 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 was examined for excessive stress and that none exists.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic 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 seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-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. Preapproval 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).
- D. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for fire protection system piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

<Retain "Coordination Drawings" Paragraph for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.>

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For [Professional engineer] [and] [testing agency].
- C. Welding Certificates.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.7 WARRANTY/GUARENTEE

- A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

- A. Product Design and Selection: All products shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.
- B. Acceptable Manufacturers: For the specified products acceptable manufactures are as follows:
1. Elastomeric Isolation Pads and Mounts:
 - a. Amber/Booth.
 - b. Korfund Dynamics.
 - c. Peabody Noise Control, Inc.
 - d. Mason Industries, Inc.
 - e. Vibration Mountings & Controls, Inc.
 2. Open Spring Isolators:
 - a. Amber/Booth.
 - b. Korfund Dynamics.
 - c. Peabody Noise Control, Inc.
 - d. Mason Industries, Inc.
 - e. Vibration Mountings & Controls, Inc.
 3. Elastomeric Hangers:
 - a. Amber/Booth.
 - b. Korfund Dynamics.
 - c. Peabody Noise Control, Inc.
 - d. Mason Industries, Inc.
 - e. Vibration Mountings & Controls, Inc.
 4. Spring Hangers:
 - a. Amber/Booth.
 - b. Korfund Dynamics.
 - c. Peabody Noise Control, Inc.
 - d. Mason Industries, Inc.
 - e. Vibration Mountings & Controls, Inc.
 5. Restraint Channel Bracing:
 - a. Cooper B-Line, Inc.
 - b. Hilti, Inc.
 - c. Mason Industries, Inc.
 - d. Unistrut.
 6. Restraint Cables:

- a. Kinetics Noise Control, Inc.
 - b. Loos & Co., Inc.
 - c. Vibration Mountings & Controls, Inc.
7. Seismic Restraint Accessories:
- a. Cooper B-Line, Inc.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 - d. TOLCO.
8. Anchor Bolts:
- a. Cooper B-Line, Inc.
 - b. Hilti, Inc.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.

2.2 PERFORMANCE REQUIREMENTS <Coordinate hangers and support systems with structural engineer.>

A. Seismic-Restraint Loading: <Delete this section if not applicable> <if applicable edit for project requirements>

1. Site Class as Defined in the IBC: [A] [B] [C] [D] [E] [F].
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: [I] [II] [III].
 - a. Component Importance Factor: [1.0] [1.5].
 - b. Component Response Modification Factor: [1.5] [2.5] [3.5] [5.0].
 - c. Component Amplification Factor: [1.0] [2.5].
3. Design Spectral Response Acceleration at Short Periods (0.2 Second):
4. Design Spectral Response Acceleration at one (1) Second Period:
5. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they are subjected.

2.3 ELASTOMERIC ISOLATION PADS (NP)

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements provide products by one (1) of the following:
 - a. Amber/booth. Type NR
 - b. Korfund Dynamics. Type KD

- c. Peabody Noise Control, Inc. Type NPS
 - d. Mason Industries, Inc. Type WSW
 - e. Vibration Mountings & Controls, Inc. Series Shear Flex
- 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Verify availability of various pad materials and their properties with manufacturers.
 - 5. Pad Material: Oil and water resistant with elastomeric properties.
 - 6. Surface Pattern: Waffle pattern.

2.4 ELASTOMERIC ISOLATION MOUNTS (DNP)

A. Double-Deflection, Elastomeric Isolation Mounts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Amber/Booth. Type RV
 - b. Korfund Dynamics. Type F
 - c. Peabody Noise Control, Inc. Type RD
 - d. Mason Industries, Inc. Type ND
 - e. Vibration Mountings & Controls, Inc. Series RD
- 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
- 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS (FSN)

A. Freestanding, Laterally Stable without any housing, Open-Spring Isolators:

- 1. Manufacturers; Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Amber/Booth. Type SW
 - b. Korfund Dynamics. Type WSL
 - c. Peabody Noise Control, Inc. Type FDS
 - d. Mason Industries, Inc. Type SLF
 - e. Vibration Mountings & Controls, Inc. Series A

2. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50% of the required deflection at rated load.
4. Lateral Stiffness: More than 80% of rated vertical stiffness.
5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
6. Spring element in isolator shall either be set in Neoprene cup and have steel washer to distribute load evenly over Neoprene: or, isolator shall be mounted on unit Double Neoprene Pad (DNP) isolator. If DNP isolator is used, provide rectangular bearing plate of sufficient size to load pad uniformly in range of 40 to 50 psi. If spring isolator is supplied with Neoprene friction pad, use stainless steel, aluminum or galvanized steel plate between friction pad and DNP isolator.
7. If isolator is to be fastened to building structure and unit DNP isolator is used under bearing plate, neoprene grommets shall be provided for each bolt hole in base plate. Bolt holes shall be properly sized to allow for grommets. Hold-down bolt assembly shall include washers to distribute load evenly to grommet. Bolts and washers are to be galvanized.
8. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two (2) steel tubes separated by a minimum one half (1/2) inch thick neoprene.
 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.7 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum one half (1/2) inch thick neoprene.
 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.8 ELASTOMERIC HANGERS (HN)

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Amber/Booth. Type BRD-A

- b. Korfund Dynamics. Type H
 - c. Peabody Noise Control, Inc. Type RH of FH
 - d. Mason Industries, Inc. Type HD
 - e. Vibration Mountings & Controls, Inc. Type RHD or RFD
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.9 SPRING HANGERS (HS)

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Amber/Booth. Type BSWR-A
 - b. Korfund Dynamics. Type VSX-30
 - c. Peabody Noise Control, Inc. Type SRH or RFH
 - d. Mason Industries, Inc. Type 30N
 - e. Vibration Mountings & Controls, Inc. Type SH
2. Isolation hangers shall consist of free-standing laterally stable steel spring set into Neoprene cup, contained within steel housing.
3. Neoprene cup shall be manufactured with grommet (or other means) to prevent hanger rod from contacting hanger housing. Provide steel washer in Neoprene cup to evenly distribute load onto Neoprene.
4. Spring diameter and hanger housing lower hole sizes shall be large enough to permit hanger rod to swing through 30-degree arc before contracting housing.
5. Spring elements shall have minimum additional travel to solid equal to 50% of actual deflection.

2.10 SPRING HANGERS (HSN)

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Amber/Booth. Type BSWR-A
 - b. Korfund Dynamics. Type VSX-30
 - c. Peabody Noise Control, Inc. Type SRH or RFH

- d. Mason Industries, Inc. Type 30N
 - e. Vibration Mountings & Controls, Inc. Type SH
2. Isolation hangers shall consist of free-standing, laterally stable steel spring and Neoprene or glass fiber element in series, contained within steel housing.
 3. Provide Neoprene neck busing (or other means) where hanger rod passes through hanger housing to prevent rod from contacting hanger housing.
 4. Spring diameter and hanger housing lower hole sizes shall be large enough to permit hanger rod to swing through 30-degree arc before contacting housing.
 5. Spring elements shall have minimum additional travel to solid equal to 50% of actual deflection.

2.11 UNIT FSNTL (FLOOR SPRNG AND NEOPRENE, TRAVEL-LIMITED)

- A. Spring isolators shall be free-standing and laterally stable without any housing.
- B. Spring diameter shall be not less than 80% of compressed height of spring at design load, and with minimum additional travel to solid equal to 50% of actual deflection.
- C. Springs shall be so designed that ratio of horizontal stiffness to vertical stiffness is approximately one.
- D. Mounts shall have leveling bolts and vertical travel limit stops to control extension when weight is removed. Travel limit stops shall be capable of serving as blocking during erection of equipment. Minimum clearance of one quarter (1/4) inch shall be maintained around restraining bolts and between limit stops and spring to avoid interference with spring action.
- E. Spring element in isolator shall either be set in Neoprene cup with steel washer to distribute load evenly over Neoprene, or each isolator shall be mounted on unit NP isolator. If NP isolator is used, provide rectangular bearing plate of sufficient size to load pad uniformly in range of 40 psi to 50 psi. If spring isolator is supplied with Neoprene friction pad, use stainless steel, aluminum or galvanized steel plate between friction pad and NP isolator. NP isolator, separator plate and friction pad shall be permanently adhered to one another and to bottom of bearing plate.
- F. If isolator is to be fastened to building structure and unit NP isolator is used under bearing plate, provide Neoprene grommets for each bolt hole in base plate. Bolt holes shall be properly sized to allow for grommets. Hold-down bolt assembly shall include washers to distribute load evenly to grommet. Bolts and washers are to be galvanized.
- G. Unit FSNTL isolators shall be one of the following product with appropriate Neoprene pad (if used) selected from Unit NP.
 1. Amber/Booth. Type SW (with limit stops)
 2. Korfund Dynamics. Type WSCL
 3. Peabody Noise Control, Inc. Type FLS

- | | | |
|----|--------------------------------------|------------|
| 4. | Mason Industries, Inc. | Type SLR |
| 5. | Vibration Mountings & Controls, Inc. | Series AWR |

2.12 UNIT FN (FLOOR NEOPRENE)

- A. Isolators shall be Neoprene-in-sheer type with steel reinforced top and base.
- B. Metal surfaces shall be covered with Neoprene with ribbed top and bottom surfaces.
- C. Bolt holes shall be provided in base and top shall have threaded fastener.
- D. Mounts shall include leveling bolts that may be rigidly connected to equipment.
- E. Unit FN isolators shall be one (1) of the following products:

- | | | |
|----|--------------------------------------|-----------|
| 1. | Amber/Booth. | Type RV |
| 2. | Korfund Dynamics. | Type F |
| 3. | Peabody Noise Control, Inc. | Type RD |
| 4. | Mason Industries, Inc. | Type ND |
| 5. | Vibration Mountings & Controls, Inc. | Series RD |

2.13 EQUIPMENT BASES <Delete bases not applicable to project.>

A. Unit BSR (Base-Steel Rail)

- 1. Steel rail bases shall consist of structural steel sections sized to provide rigid beam which will not twist, deform or deflect sufficiently to negatively affect operation of supported equipment or vibration isolation mounts.
- 2. Rail bases shall include side mounting brackets for attachment of vibration isolators.
- 3. Unit BSR bases shall be supplied by isolator manufacturer and shall be one (1) of following products:

- | | | |
|----|--------------------------------------|----------------------|
| a. | Amber/Booth. | Type C or CIS |
| b. | Korfund Dynamics. | Type Steel Base Rail |
| c. | Mason Industries, Inc. | Type R or ICS |
| d. | Peabody Noise Control, Inc. | Type KRB or KFB |
| e. | Vibration Mountings & Controls, Inc. | Type WFR or AR |

B. Unit BSF (Base-Steel Frame)

- 1. Steel base frames shall consist of structural steel sections sized, spaced and connected to form rigid base which will not twist, rack, deform or deflect sufficiently to negatively affect operation of supported equipment or vibration isolation mounts.
- 2. Frames shall be adequately sized to support equipment and motors plus any associated pipe elbow supports, duct elbows supports, electrical control elements

or other components closely related and requiring resilient support in order to prevent vibration transfer to building structure.

3. Steel frame base thickness shall be at least 1/10 of longest dimension of base, but not more than twelve (12) inches.
4. Frame bases shall include side mounting brackets for attachment to vibration isolators.
5. Unit BSF bases shall be supplied by isolator manufacturer and shall be one (1) of the following products:

- | | | |
|----|--------------------------------------|-----------------|
| a. | Amber/Booth. | Type SW-1 |
| b. | Korfund Dynamics. | Type Steel Base |
| c. | Mason Industries, Inc. | Type WFSL |
| d. | Peabody Noise Control, Inc. | Type SFB or SRB |
| e. | Vibration Mountings & Controls, Inc. | Series WPF |

C. Unit BIB (Base-Inertia Base)

1. Concrete inertia bases shall be formed of stone-aggregate concrete (150 lb/cu ft) and appropriate steel reinforcing cast between perimeter structural steel channels.
2. Inertia bases shall be built to form rigid base which will not twist, rack, deform, deflect or crack sufficiently to negatively affect operation of supported equipment or vibration isolation mounts.
3. Inertia bases shall be adequately sized to support equipment and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements or other components closely related and requiring resilient support in order to prevent vibration transfer to building structure.
4. Inertia base thickness shall be at least one and one half (1 1/2) of longest dimension of inertia base but not less than six (6) inches.
5. Inertia bases shall include side mounting brackets for attachment to vibration isolators.
6. Steel frame and reinforcement shall be supplied by vibration isolator manufacturer. Concrete shall meet requirements of Division 3.
7. Frame and reinforcement for BIB bases shall be one (1) of following products:

- | | | |
|----|--------------------------------------|---------------------|
| a. | Amber/Booth. | Type Custom |
| b. | Korfund Dynamics. | Type RCPF |
| c. | Mason Industries, Inc. | Type KSL |
| d. | Peabody Noise Control, Inc. | Type CIB-L or CIB-H |
| e. | Vibration Mountings & Controls, Inc. | Series WPF |

D. Unit BC (Base-Curb)

1. Curb type isolation bases shall be prefabricated assembly consisting of extruded aluminum frame and steel spring isolation system that fits over roof curb and under isolated equipment.
2. Aluminum frame shall be sufficiently rigid to support equipment load without detrimental twist or deflection.

3. Select and position spring isolators along curb to achieve minimum static deflection specified. Static deflection shall be constant around base periphery.
4. Springs shall be free-standing, laterally stable with diameter of not less than 80% compressed height, and have additional travel to solid at least 50% of actual deflection.
5. Provide resilient Neoprene snubbers at corners of base to limit horizontal movement of equipment under wind load to one quarter (1/4) inch.
6. Curb base shall be made weather-tight by sealing all around periphery with closed-cell Neoprene or flexible vinyl. Sealing shall not inhibit vibration isolation of spring elements. Use closed-cell sponge gasket or field caulking between equipment and isolation curb base, and between isolation curb base and roof curb to form weather-tight seal.
7. Spring isolators used in isolation curbs shall be protected as described above.
8. Unit BC isolation curb bases shall be supplied by isolator manufacture and shall be one (1) of following products:
 - a. Mason Industries, Inc. Type CMAB
 - b. Peabody Noise Control, Inc. Type ASR
 - c. Vibration Mountings & Controls, Inc. Series ATR

2.14 RESTRAINT CHANNEL BRACINGS <Coordinate with structural engineer for requirements.>

- A. Manufacturers; Subject to compliance with requirements, provide products by one (1) of the following:
 1. Cooper B-Line, Inc.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. Unistrut.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.15 RESTRAINT CABLES <Coordinate with structural engineer for requirements.>

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 1. Kinetics Noise Control, Inc.
 2. Loos & Co., Inc.
 3. Vibration Mountings & Controls, Inc.

- B. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.16 RESILIENT LATERAL GUIDES

- A. These units shall be standard product of vibration isolation mounting manufacture incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.
- B. Resilient lateral guides shall be one (1) of the following products:
 - 1. Amber/Booth. Type Custom
 - 2. Korfund Dynamics. Type Custom
 - 3. Mason Industries, Inc. Type ADA
 - 4. Peabody Noise Control, Inc. Type RGN
 - 5. Vibration Mountings & Controls, Inc. Type MDPA

2.17 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
 - 4. TOLCO.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections, reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.18 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cooper B-Line, Inc.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. Mechanical Anchor bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.19 ADHESIVE ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.20 VIBRATION ISOLATION SCHEDULE <Edit Schedule as applicable to Project.>

EQUIPMENT	ISOLATOR TYPE	MINIMUM STATIC DEFL (IN)	BASE TYPE	REMARKS
Air Handling Unit Fans	FSN	1.5	BSF	Thrust Restraints
In-Line Return and Exhaust Fans	HN	1.5	---	
Base-Mounted Exhaust & Return Fans Above Grade	FSN	1.5	BSF	Thrust Restraints
Base-Mounted Exhaust & Return Fans On Grade	FSN	0.35	---	
Curb-Mounted Exhaust Fans <1 hp				Internal Neoprene Grommets
Pumps Above Grade	FSN	1.0	BC	
Pumps on Grade	FN	0.30	---	
In-Line Pumps	HSN	0.50		
Controls Compressor On Grade	NP	---	---	
Controls Compressor Above Grade	FSN	2.0	BIB	
Condensate Pumps	NP	---	---	

Air Handling Equipment Above Grade	FSN	1.5	BIB	
Cooling Towers	FSNTL	1.5	BSR	On dunnage above roof
Chillers (On Grade)	FN	0.35	---	
Vacuum Pumps	FSN	1.0	---	
Air Compressors	FS	1.0	---	

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic - and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance 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

A. Major Equipment:

1. Unless otherwise shown or specified, major floor-mounted equipment shall be set on housekeeping type concrete pads. See architectural or structural drawings for details.
2. Flexible duct connections shall be installed at fan unit intakes, fan unit discharges, and wherever else shown on drawings.
3. Electrical connections to vibration-isolated equipment shall be flexible. Connections made for conduit less than 1 inch may be either Unit FEC-A or FEC-C. For conduit sizes 1 inch and larger use Unit FEC-A.
4. Unit TR (Thrust Restraints) shall be installed on equipment as called for in schedule on drawings or specified hereunder.

B. Miscellaneous Mechanical Equipment:

1. Miscellaneous pieces of mechanical equipment such as heat exchangers, pressure reducing stations, domestic water heaters, storage tanks, condensate receiver tanks

and expansion tanks shall be vibration-isolated from building structure by Unit NP or Unit HN isolators unless their position in piping system requires higher degrees of isolation as called for under pipe isolation requirements.

C. Pipes:

1. Chilled water, condenser water, hot water, steam, reheat and refrigerant piping within mechanical rooms or within fifty (50) feet total pipe length (whichever is longer) of connected vibration-isolated equipment (chillers, pumps, air handling units, pressure reducing stations, etc.), and all of above piping that is six (6) inches or larger, shall be isolated from building structure by vibration mounts, resilient pipe guides, and resilient penetration sleeve/seals.
2. Isolators for first three support points adjacent to connected equipment shall achieve half of specified static deflection of isolators supporting connected equipment. When required static deflection of these pipe isolators is greater than 0.50 inches, Unit FSN or HSN isolators, (whichever is applicable for mounting condition) shall be used. When required static deflection is less than or equal to 0.50 inches, Unit FN HN isolators (whichever is applicable for mounting condition) shall be used.
3. All other pipe support isolators within specified limits shall be either Unit FN or HM (whichever is applicable to mounting condition) achieving 0.25 inches static deflection.
4. Where lateral support of pipe risers is required within specified limits, use resilient lateral supports.
5. Pipes within specified limits that penetrate building construction shall be isolated from building structure by (Unit RPS-A or Unit RPS-B) resilient penetrating sleeve/seals.
6. Drain piping connected to vibration isolated equipment shall not contact building structure or other non-isolated system unless it is resiliently mounted as described above.

D. Electrical Equipment:

1. Transformers, dimmer racks and switch gear shall be mounted on Unit DNP isolators.
2. Electrical connections to vibration-isolated electrical equipment shall be made using flexible electrical connections. Connections made in conduits less than 1 inch may be Unit FEC-A or FEC-B. For conduits sized 1 inch and larger, use Unit FEC-A.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION
<Coordinate with structural engineer for requirements.>

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Architectural Specification Sections Cast-in-Place Concrete, and/or "Miscellaneous Cast-in-Place Concrete."

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- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Architectural Specification Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Piping Restraints:
1. Comply with requirements in MSS SP-127.
 2. Space lateral supports a maximum of forty (40) feet o.c., and longitudinal supports a maximum of eighty (80) feet o.c.
 3. Brace a change of direction longer than twelve (12) feet.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.
- I. 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.
- J. 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.
- K. 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 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Specification Sections "Vibration and Seismic Controls for HVAC Piping" and/or "HVAC Piping Systems and Specialties" for piping flexible connections.

3.5 FIELD QUALITY CONTROL <Delete if not required for projects.>

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, 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 (4) of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90% of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 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.

END OF SECTION 230548