

SECTION 15241 – MECHANICAL VIBRATION CONTROLS AND SEISMIC RESTRAINTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

- A. Furnish and install all necessary vibration isolation materials to eliminate excessive noise and vibration from all building mechanical systems.

- B. Seismic restraints for all systems shall be installed in accordance with:

- | | | |
|-----|---|-------------------------|
| 1. | Code | IBC 2003 |
| 2. | Use group | III |
| 3. | Seismic design category | C |
| 4. | Site classification | C |
| 5. | Building I _p (Importance Factor) | 1.5 |
| 6. | All Life safety systems | Importance Factor = 1.5 |
| 7. | Emergency electrical | Importance Factor = 1.5 |
| 8. | Hazardous systems | Importance Factor = 1.5 |
| | a. Oil piping | Importance Factor = 1.5 |
| | b. Gas piping | Importance Factor = 1.5 |
| | c. Gas Vents | Importance Factor = 1.5 |
| 9. | HVAC | |
| | a. All smoke exhaust systems | Importance Factor = 1.5 |
| | b. Steam system | Importance Factor = 1.5 |
| | c. Condensate system | Importance Factor = 1.5 |
| | d. Snow melting piping system | Importance Factor = 1.0 |
| | e. Hospital ductwork | Importance Factor = 1.5 |
| 10. | Plumbing systems | |
| | a. Medical gas | Importance Factor = 1.5 |
| | b. Nitrogen piping system | Importance Factor = 1.5 |
| | c. Medical compressed air system | Importance Factor = 1.5 |
| | d. Nitrous oxide piping system | Importance Factor = 1.5 |
| | e. Domestic water system | Importance Factor = 1.5 |

- f. Waste and vent system Importance Factor = 1.0
- g. Storm Drain system Importance Factor = 1.0

11. Other systems

- a. All other ductwork systems Importance Factor = 1.5
- b. All other piping systems Importance Factor = 1.5
- c. All other electrical systems Importance Factor = 1.5
- d. All other plumbing systems Importance Factor = 1.5
- e. Control conduits Importance Factor = 1.5

C. Piping types

1. High deformability piping:

- a. Welded steel
- b. Welded stainless steel
- c. Socket welded steel
- d. Grooved steel that is ASME B31.1
- e. Braised copper
- f. Grooved copper

2. Limited-deformability

- a. Threaded Steel
- b. Grooved steel that is not ASME B31.1
- c. Soldered copper

3. Low-deformability

- a. PVC
- b. Cast iron
- c. Glass
- d. Non-ductile plastic

D. All trapeze supported Items weighing 10 Lbs per foot or greater shall be braced. This weight shall include all pipes and conduits filled with water.

E. Secure all permits and local/state approval for the installation of all components included under this Section.

F. The work in this Section shall include the following:

- 1. Vibration isolation elements for equipment.
- 2. Equipment isolation bases.
- 3. Piping flexible connectors.
- 4. Seismic restraints for isolated equipment.
- 5. Seismic restraints for non-isolated equipment.

6. Seismic restraints for ductwork
7. Seismic restraints for piping
8. Certification of seismic restraint designs and installation supervision.
9. Certification of seismic attachment of housekeeping pads.

1.3 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.4 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.
- B. Material standards shall be as specified or detailed hereinafter and as follows:
 1. NEBB– Procedural Standards for Measuring Sound and Vibration; National Environmental Balancing Bureau.
 2. NEBB– Sound and Vibration in Environmental Systems; National Environmental Balancing Bureau.
 3. SMACNA – Guidelines for Seismic Restraint of Mechanical Systems.
 4. ASHRAE Guidelines – HVAC Applications; Chapter– Sound and Vibration Control, Chapter – Seismic Restraint Design, Latest Edition.

1.5 SUBMITTALS

- A. See Section 15050 and General Conditions for additional requirements.
- B. The Vibration Isolation Submittal shall include descriptive data for all products and materials including the following:
 1. Product Descriptions
 - a. A complete description of products to be supplied, including product data, dimensions, specifications and installation instructions.
 - b. An itemized list of isolated and non-isolated equipment. Detailed schedule and selection data for each vibration isolator and seismic restraint supporting equipment, including:
 - 1) Equipment identification mark
 - 2) Isolator type
 - 3) Actual load

- 4) Static deflection expected under actual load
 - 5) Specified minimum static deflection
 - 6) Additional deflection-to-solid under load
 - 7) Ratio of spring height under load to spring diameter
 - 8) Base type
 - 9) Seismic restraint type
- c. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
2. Show equipment base construction for all equipment, including dimensions, structural member sizes and support point locations.
 3. Indicate isolation devices selected with complete dimensional and deflection data.
 4. Show all methods of suspension and support for ceiling hung equipment.
 5. Detail methods of isolation for ducts and pipes piercing walls and slabs.
 6. Provide specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.
 7. Provide special details necessary to convey complete understanding of the work to be performed.
- C. Seismic Analysis and Certification submittals shall include the following:
1. Seismic restraint calculations must be provided for all connections of equipment to the structure.
 2. Calculations to support seismic restraint designs shall be stamped by a registered Professional Engineer.
 3. Analysis must indicate calculated dead loads, derived loads, and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and weld length.
 4. A seismic design liability insurance certificate must accompany all submittals.
 5. Coordinate all hangers and supports.
 6. Provide Approved Agencies Certificate of Compliance meeting Seismic Category D for all components. Tests shall include anchorage, structural and on line capability from analytical or shaker test method.
 - a. Where the requirements of this specification cannot be met by any vendor, the contractor will submit a written summary indicating the lack of resources.
- D. Submission of samples may be requested for each type of vibration isolation and seismic device. After approval, samples will be returned for installation at the job if requested. All costs associated with submission of samples shall be borne by the Contractor.

1.6 QUALITY ASSURANCE

- A. All vibration isolators shall have calibration markings or some method to determine the actual deflection under the imposed load after installation and adjustment.
- B. All isolators shall operate within the linear portion of their load versus deflection curves. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of at least 50% above the design deflection.
- C. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than $\pm 10\%$, and shall be non-resonant with equipment forcing frequencies or support structure natural frequencies.
- D. All neoprene components shall have a shore hardness of 30 to 50 $\pm 5\%$, after minimum aging of (20) days or equal oven aging.
- E. Substitution of internally isolated and restrained equipment in lieu of the isolation and restraints specified in this Section is acceptable provided all conditions of this Section are met. The equipment manufacturer shall provide a letter of guarantee stating that the specified noise and vibration levels will be obtained and that the seismic restraints shall be in compliance with these specifications. All costs for converting to the specified external vibration isolation and/or restraints shall be borne by the equipment manufacturer/installing contractor should submissions or installations be found to be unacceptable pursuant to the intent of this specifications.
- F. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- G. Upon completion of the work, the Architect or Architect's representative shall inspect the installation and shall inform the Installing Contractor of any further work that must be completed. Make all adjustments as directed by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.
- H. Manufacturer Responsibility
 - 1. Manufacturer of vibration and seismic control equipment shall have the following responsibilities:
 - a. Determine vibration isolation and seismic restraint sizes and locations.
 - b. Provide equipment vibration isolation and seismic restraints as scheduled or specified.
 - c. Guarantee specified isolation system deflections.
 - d. Provide installation instructions, drawings and field supervision to ensure proper installation and performance of systems.

- e. Provide certification by a licensed engineer that all mounts and restraints meet the project requirements for seismic loading.
2. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed Civil or Structural Engineer.
 3. Licensed Engineers shall be licensed in the project state.
- I. Contractor Responsibilities
1. The Contractor performing the work on equipment in the section shall have the following responsibilities.
 - a. Identify the components that are part of the Quality Assurance Plan.
 - 1) All flammable, combustible and highly toxic piping and their associated mechanical systems.
 - 2) All ductwork containing hazardous materials.
 - 3) All equipment using combustible or toxic energy sources.
 - b. Identify all Special inspection and Testing.
 - c. List control procedures within the contractor's organization including methods and frequency of reporting and their distribution.
 - d. List personnel and their qualifications exercising control over the seismic aspects of the project.
 2. Purchased and/or fabricated equipment must be designed to safely accept external forces of 1.8 g load in any direction for all rigidly supported equipment, piping and ductwork without failure and permanent displacement of the equipment. Resiliently supported equipment, piping and ductwork and Life safety equipment such as fire pumps, smoke exhaust fans, emergency generators and other life safety designated equipment must be capable of accepting external forces of up to 3.6 g in any direction without permanent displacement or failure of the equipment.

1.7 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system and ASTM F708 for design and installation of pipe hangers.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.8 DELIVERY, STORAGE AND HANDLING

- A. All vibration control and SEISMIC restraint equipment shall be delivered in containers and shall be kept in a dry and protected area.
- B. All exposed hangers, supports, etc. shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

PART 2 – PRODUCTS

2.1 ISOLATORS AND RESTRAINTS – GENERAL

- A. Acceptable Manufacturers subject to compliance to specifications.
 - 1. Mason Industries (MI)
 - 2. Amber/Booth (AB)
 - 3. Kinetics Noise Control (KNC)
 - 4. Vibration Eliminator Co. (VEC)
 - 5. Vibration Mountings & Controls (VMC)
- B. The Mechanical Contractor shall provide necessary vibration isolation materials to eliminate excessive noise and vibration from being transmitted from HVAC equipment to the occupied areas of the structure, and to serve as the basis for seismic restraint design for the entire HVAC system within the building. This includes all non-structural components such as, but not limited to, air handlers, fans, pumps, tanks, ductwork, piping, etc. (hereinafter called equipment).
- C. Seismic restraints and vibration isolation types shall be capable of accepting, without failure, seismic forces determined in accordance with:
 - 1. International Building Code 2003
 - 2. State/Country Codes
 - 3. Local codes enforced at the specified project location.
- D. Isolators and supports shall maintain the equipment in a captive position and not short circuit isolation during normal operating conditions. Isolators shall have provisions for bolting and/or welding to the structure.
- E. All metal parts of vibration isolation units installed out-of-doors shall be cold dip galvanized, cadmium plated, or neoprene or PVC coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard #14.
- F. All base supported isolators shall have base plates with bolt holes for fastening the isolators to the support members.

- G. Isolator types are scheduled to establish minimum standards. At the Contractor's option, laborsaving 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 must not degrade the vibration isolation system.
- H. Static deflection of isolators shall be as scheduled in this Section and as shown on the drawings. All static deflections stated are the minimum acceptable deflection under actual load. Isolators shall be selected for no less than 50% reserve deflection beyond actual operating conditions.
- I. Attachment plates to be cast into housekeeping pads, concrete inserts, beam clamps, etc. that may be required for seismic compliance shall be provided by this Section.
- J. Coordinate the size, location and special requirements of vibration isolation equipment and systems with other Trades. Coordinate plan dimensions with size of housekeeping pads.

2.2 SEISMIC RESTRAINT TYPES

- A. Type I
 - 1. Type I shall comply with general characteristics of spring isolator Type A with snubbing restraint in all directions capable of supporting equipment at fixed elevations during installation. Cast or aluminum housings, except ductile iron are not acceptable.
 - 2. Type I seismic restraint shall be similar to Mason Industries Type SLRS.
- B. Type II
 - 1. Each corner or side of equipment base shall incorporate a seismic restraint snubber having a minimum of 5/8" thick resilient pad limit stop. Seismic snubbers shall be in accordance with manufacturer's recommendations.
 - 2. Type II seismic restraints shall be similar to Mason Industries Type Z-1011 or Z-1225.
- C. Type III
 - 1. Type III shall be multiple metal cable or strut type with approved fastening devices to equipment and structure. System to be field bolted to deck or to overhead structural members using 2-sided beam clamps or appropriately designed inserts for concrete. All parts of the system including cables, excluding fasteners, are to be of a single supplier to ensure seismic compliance.
- D. Type IV
 - 1. Type IV shall have double deflection neoprene isolator (minimum 0.3") encased in ductile iron or steel casing.

2. Type IV seismic restraints shall be similar to Mason Industries Type BR, RBA or RCA.

E. Type V

1. Non-isolated equipment shall be field bolted or welded (powder shots not acceptable) to the structure as required to meet seismic forces. Bolt diameter, imbedment data and/or weld length must be shown in certified calculations.

2.3 VIBRATION ISOLATOR TYPES

A. Type A (Floor Spring and Neoprene)

1. The Type A spring isolator shall:
 - a. Have a minimum outside diameter to overall height of 0.8:1.
 - b. Have corrosion resistance where exposed to corrosive environment with:
 - 1) Springs cadmium plated or electro-galvanized.
 - 2) Hardware cadmium plated.
 - 3) All other metal parts hot dip galvanized.
 - c. Have reserve deflection (from loaded to solid height) of 50% of rated deflection.
 - d. Have minimum 1/4" thick neoprene acoustical base pad on underside, unless designed otherwise.
 - e. Be designed and installed so that ends of springs remain parallel.
2. Type A isolator shall be similar to Mason Industries Type SLF.

Note: Must be used with Seismic Restraint II.

B. Type B (Floor Spring and Neoprene Travel Limited)

1. The Type B spring isolator shall be the same as Type A with the following additional features.
 - a. Built-in vertical limit stops with minimum 1/4" clearance under normal operation.
 - b. Tapped holes in top plate for bolting to equipment.
 - c. Capable of supporting equipment at fixed elevation during equipment installation. Installed and operating heights shall be identical.
 - d. Adjustable and removable spring pack with separate neoprene isolation pad.
2. Type B isolator shall be similar to Mason Industries Type SLR.

Note: This isolator must be bolted or welded to the structure.

C. Type C (Spring Hanger Rod Isolator)

1. Spring isolator (Type A) seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.
2. Spring diameters and hanger box shall allow 30° of hanger rod movement.
3. When used on ductwork, provide eyebolts for attachment to duct straps.
4. Type C isolator shall be similar to Mason Industries Type 30 or W30.

Note: Must be used with Seismic Restraint III.

D. Type D

1. Same as Seismic Restraint Type IV.

E. Type E (Elastomer Hanger Rod Isolator)

1. Molded (minimum 1 3/4" thick) neoprene element with projecting bushing lining the rod clearance hole. Static deflection at rated load shall be minimum 0.035".
2. Steel retainer box encasing neoprene mounting capable of supporting equipment up to (4) times the rated capacity of the element.
3. Type E isolator shall be similar to Mason Industries Type HD.

Note: Must be used with Seismic Restraint III.

F. Type F (Combination Spring/Elastomer Hanger Rod Isolator)

1. Spring and neoprene elements in a steel retainer box with the features as described for Type C and Type E isolators.
2. Type F isolator shall be similar to Mason Industries Type 30N.

Note: Must be used with Seismic Restraint III.

G. Type G (Pad Type Elastomer Isolator)

1. Pads shall be constructed of an elastomer material which is resistant to water, brine, fungus, oil and bacterial groups.
2. 0.75" minimum thickness, 50 psi maximum loading, ribbed or waffled design.
3. Minimum 0.1" deflection.
4. 1/16" galvanized steel plate between multiple pad layers.
5. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
6. Sizing and location of isolators shall be determined according to equipment loading and floor deflection factors so that the deflection among all pads is equal.
7. Type G isolators shall be similar to Mason Industries Type Super W.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

H. Type H (Pad Type Elastomer Isolator)

1. Laminated canvas duck and neoprene, maximum loading 1000 psi, minimum 1/2" thick.
2. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
3. Type H isolator shall be similar to Mason Industries Type HL.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

I. Type I (Thrust Restraints)

1. A spring element similar to Type A isolator shall be combined with steel angles, back-up plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting movement of air handling equipment to 1/4".
2. Restraint shall be easily converted in the field from a compression type to tension type.
3. Unit shall be factory precompressed.
4. Thrust restraints shall be installed on all cabinet fan heads, axial or centrifugal fans whose thrust exceeds 10% of unit weight.
5. Type I restraint shall be similar to Mason Industries Type WB.

J. Type J (Steel Rails)

1. Steel members of sufficient strength to prevent equipment flexure during operation.
2. Height saving brackets as required to reduce operating height.
3. Type J isolator shall be similar to Mason Industries Type ICS.

K. Type K (Pipe Anchors and Guides)

1. Acoustical pipe anchor or guide, consisting of a telescopic arrangement of (2) sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.
2. Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction (anchors only).
3. Allowable loads on isolation materials shall not exceed 500 psi, and the design shall be balanced for equal resistance in any direction.
4. Anchors and guides must be bolted or welded to meet seismic criteria.
5. Type K anchor shall be similar to Mason Industries Type ADA.

L. Type L (Isolated Clevis Hanger)

1. Combination clevis or rod roller hanger and a Type C, E, or F, isolation hanger.
2. System shall be precompressed to allow for rod insertion and standard leveling.
3. Type L hanger shall include Mason Industries Type CCB clevis brace.

2.4 EQUIPMENT BASES

- A. All curbs and roof rails are to be bolted or welded to the building steel or concrete deck to attain acceleration criteria and shall be wind restrained for 110 mph wind loads.
- B. Type B-1 (Integral Structural Steel Base)
1. The integral structural steel base shall be reinforced as required to prevent base flexure at equipment start-up and misalignment of driver and driven units. Centrifugal fan bases shall be complete with motor slide rails and shall be drilled for driver and driven units.
 2. Height saving brackets shall be provided, as required, to reduce operating height and maintain 1" operating clearance under base.
 3. Member depth shall be a minimum of 1/10 of the longest unsupported span.
 4. Type B-1 equipment base shall be similar to Mason Industries Type M or WF.

Note: Must be used with Restraint I, II or IV.

C. Type B-2 (Concrete Inertia Base)

1. Concrete inertia base shall have rectangular structural concrete forms for floating foundations. Base for split-case pumps shall be large enough to support elbows. The base depth shall be a minimum of 1/12 the longest span, but not less than 6" or greater than 14". Forms shall include concrete reinforcement consisting of 1/2" bars or angles welded in place on 6" centers both ways in a layer 1 1/2" above the bottom. Provide an additional top layer of reinforcing for all bases exceeding 10'-0" in one direction.
2. Isolators shall be set into pocket housings which are an integral part of the base construction and set at the proper height to maintain 1" clearance below the base. Base shall be furnished with templates for equipment attachment and anchor bolt sleeves.
3. Type B-2 equipment base shall be similar to Mason Industries Type K or KIPWF.

Note: Must be used with Restraint I, II or IV.

D. Type B-3 (Spring Roof Curb)

1. Curb mounted rooftop equipment shall be mounted on structural spring isolation curbs that bear directly on the roof support structure, and are flashed and waterproofed into the roof's membrane waterproofing system. Equipment manufacturer's curb shall not be used.
2. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Springs shall be Type A.
3. Curbs shall be thermal and sound attenuating type utilizing standard 2" roof insulation supplied and installed by the Roofing Contractor.
4. Unit shall be provided with wood nailer and flashing.
5. Curbs shall meet all NRCA Standards.
6. Curbs shall include a means of incorporating a sound barrier package, Type SBC-3 consisting of (2) layers of waterproof sheetrock furnished and installed by others.

7. Curbs installed on pitched roofs shall be factory built to compensate for elevation changes.
8. Curbs shall be similar to Mason Industries Type RSC having a minimum 3" rated static deflection.

E. Type B-4 (Flashable Roof Rail System)

1. Rooftop fans, condensing units, air handlers, etc. shall be mounted on continuous support piers that combines equipment support and isolation into (1) assembly.
2. Rails shall incorporate Type A isolators which are adjustable, removable and interchangeable after equipment has been installed.
3. The system shall maintain the same installed and operating height with or without the equipment load.
4. The system shall have full plywood nailers on all (4) sides, designed to accept membrane waterproofing and shall be dry galvanized or plastic coated.
5. Unit to be supplied with flashing.
6. Roof rail shall be similar to Mason Industries Type R-7000 having a minimum 3" rated static deflection.

F. Type B-5 (Roof Rail Base)

1. Rails shall be constructed from structural steel angles sized as required to prevent flexure and misalignment under load.
2. Each rail shall be the full length of the supported equipment and be welded to a series of Type B isolators. Bolt-on angle cross ties at the ends and center shall form (1) rigid platform.
3. Roof rail shall be similar to Mason Industries Type TRSLR.

G. Type B-6 (Non-Isolated Roof Curb)

1. Non-isolated, curb mounted rooftop equipment shall be mounted on structural curbs that meet the acceleration criteria hereinbefore defined.
2. Curbs shall accept standard 2" roof insulation furnished and installed by the Roofing Contractor.
3. Non-isolated curbs shall be similar to Mason Industries Type RRC.

2.5 FLEXIBLE PIPE CONNECTOR

A. All flexible connectors shall be:

1. Installed on the equipment side of the shutoff valves, horizontal and parallel to equipment shafts whenever possible. All piping between the flexible connector and the equipment shall be independently supported off the equipment base.
2. Provided wherever rigidity supported piping is connected to equipment.

B. Type FC-1 (Elastomer Connector)

1. Manufactured of nylon tire cord and EPDM, both molded and cured in hydraulic presses. Neoprene used in lieu of EPDM is not acceptable.
2. Straight connectors to have (2) spheres reinforced with a molded in external ductile iron ring between the spheres.
3. Rated at 250 psig/170°F, dropping in a straight line to 170 psig/250°F for sizes 1 1/2" to 12".
4. All sizes shall employ control cables with neoprene end fittings isolated from anchor plates by means of 1/2" bridge bearing neoprene bushings.
5. Connectors shall be installed pre-extended per manufacturer's recommendations to prevent elongation under pressure.
6. Minimum safety factory of 3.6:1 at maximum pressure ratings shall be certified by test reports. Submittals shall also include (2) test reports by independent consultants showing minimum reduction of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies.
7. Connectors bolted to Victaulic type coupling or gage, butterfly or check valves to have a minimum 5/8" flange spacer installed between the connector and the coupling flange.
8. Connectors for pipe size 2" and smaller shall have threaded female union couplings on each end. Larger pipe sizes shall be fitted with flange couplings.
9. Type FC-1 flexible connector shall be similar to Mason Industries Super-Flex Type MFTNC or MFTFU.

C. Type FC-2 (Flexible Stainless Steel Hose)

1. Stainless steel hose and braid rated with 3:1 safety factor.
2. 2" and smaller with male nipples, 2 1/2" and larger with fixed steel flanges.
3. Lengths as follows:

Size		Length	Size		Length	Size		Length
1/2	x	9	2	x	14	8	x	22
3/4	x	10	2 1/2	x	13	10	x	26
1	x	11	3	x	14	12	x	28
1 1/4	x	12	4	x	15	14	x	30
1 1/2	x	13	5	x	19	16	x	32
			6	x	20			

4. Type FC-2 flexible connector shall be similar to Mason Industries Type BSS.

D. Type FC-3 (Unbraided Exhaust Hose)

1. Low pressure stainless steel annularly corrugated with flanged ends.
2. Maximum temperature of 1500°F.

3. Lengths (in inches) as follows:

Size		Length	Size		Length
2 1/2	x	15	8	x	22
3	x	16	10	x	26
4	x	17	12	x	28
5	x	18	14	x	30
6	x	19	16	x	32

4. Type FC-3 flexible connector shall be Mason Industries Type SDL-RF or equal by approved manufacturer.

E. Type FC-4 (Bronze Braided Flexible Hose)

- Bronze hose and braid rated with a minimum 3:1 safety factor (minimum 150 psi).
- Copper tube ends.
- Minimum lengths (in inches) as follows:

Size		Length	Size		Length	Size		Length
1/8	x	7 1/2	3/4	x	11 1/2	3	x	27
1/4	x	8 1/4	1	x	13	3 1/2	x	32
3/8	x	9	1 1/4	x	14 3/4	4	x	33
1/2	x	9 3/4	1 1/2	x	17	5	x	41
5/8	x	10	2	x	20	6	x	48
			2 1/2	x	24			

4. Type FC-4 flexible connector shall be similar to Mason Industries Type BFF.

F. Seismic Expansion Joints

- Provide seismic expansion joints on all ducts, piping, conduits or other systems crossing building expansion seismic joints. Provide these joints to allow for the movement in the XY&Z direction as indicated on the structural documents.

2.6 VIBRATION ISOLATION SCHEDULE

Equipment	HP	Mtng	On Grade ****				Above Grade			
			Isol	Defl	Base	Restr	Isol	Defl	Base	Restr
Air Conditioning Condensers, Air Cooled Chillers		Roof	---	---	---	---	A	2.50	B-1	I
Air Cooled Chillers		Flr	A	1.0	B-1	II	---	---	---	---

Equipment	HP	Mtng	On Grade ****				Above Grade			
			Isol	Defl	Base	Restr	Isol	Defl	Base	Restr
Air Conditioning Units (DX)		Flr	A	1.0	---	II	A	1.0	B-1	I,II
		Clg	---	---	---	---	F	1.0	---	III
Base Mounted Pumps	to 15	Flr	A	1.0	B-2	II	A	1.5	B-2	I,II
	>15	Flr	A	1.5	B-2	II	A	2.0	B-2	I,II
Axial Fans		Flr Clg	A&I	.75	B-1	II	A** F&I	See Guide	B-2	
In Line Pump		Clg	---	---	---	---	F	.30	---	III
Cabinet Type Fans & Packaged AHUs	To 1	Flr	D	.50	---	IV	D	See	---	IV
		Clg	---	---	---	---	Guide	---	---	
Cabinet Type Fans & Packaged AHUs	>1	Flr	A	1.0	---	II	A**	See	---	I,II
		Clg	---	---	---	---	F	Guide	---	III
Centrifugal Fans		Flr	A	1.0	B-1	II	A**	See	B-2	I,II
		Clg	---	---	***	---	F	Guide	***	III
Plenum Fan		Flr	A	1.0	B-1	II	A**	See	B-2	I,II
		Clg	---	---	***	---	F	Guide	***	III
Centrifugal Fans Arrangement 9 and 10		Flr	A	1.0	B-1	II	A**	See	B-2	I,II
		Clg	---	---	---	---	F	Guide		III
Curb Mounted Equipment		Roof	---	---	---	---	---	---	B-6	V
Other than AHU*****		Flr				V				V
Rooftop AHU >10 Ton		Roof	---	---	---	---	A	2.50	B-3	V
Unit/Cab. Heaters		Clg	---	---	--	--	E	.30	---	III
Air Compressor; Medical & WAGD Vacuum Pumps; Medical & Instrument Air Compressors		Flr	A	1.0	B-2	II	A**	See	B-2	I,II
							F	Guide	---	III
Cooling Towers			B	.75	B-1	II	B	4.5	B-1	II
Centrifugal Chiller			D	.5	---	IV	A	2"	---	II
Refrigerated Dryer			---	---	---	---	D	.5	---	IV
Steam PRV's		Flr	A	.75		I, II	A	.75		I, II
		Clg	---	---	---	---	F	.75	---	III

* Used on vertically arranged units. Rails shall be 1.5 times the unit height.

** Substitute Type B isolator for Outdoor installations.

*** Substitute Type B-2 base for floor mounted Class 2 and 3 fans.

**** "On Grade" shall mean slab on grade only.

***** Fans in all units shall be isolated in accordance with chart.

Notes:

1. "Isol", "Base" and "Restr" columns indicate letter type as appears in the specs.
2. "Mtng" refers to method of support of equipment from the structure.

3. "See Guide" indicates isolator deflection selection to be taken from Deflection Guide below.

Deflection Guide	
RPM	MW Deflection
<400	3.5"
<600	2.5"
<800	2.0"
>800	1.5"

PART 3 – EXECUTION

3.1 GENERAL

- A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and submittal data. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.
- B. Design Criteria
 1. All mechanical equipment such as pumps, heat pumps, fans, air handling units, etc. shall be isolated from the building structure by means of noise and vibration isolators.
 2. All piping ductwork in mechanical equipment rooms and penthouses shall be isolated from the building structure by means of noise and vibration isolation hangers and provided with seismic restraints.
 3. Piping and/or ductwork penetrations through floors and walls shall not be rigidly connected to the building structure. Provide sleeves with clearances around the outside, as recommended by the vibration materials manufacturer. All such penetrations shall be smokeproofed and firestopped in an approved manner as hereinbefore specified.
 4. Generally, isolation facilities shall be designed to limit equipment room floor or roof loading to a maximum of 50 lbs./sq.ft. and vibration isolators shall be carefully and specifically selected for each piece of equipment.
 5. Flexible duct connections at fans and air handling units shall have a minimum clear gap of 3" between metal collars. Flexible connectors exposed to the weather shall be weatherproofed by the Mechanical Contractor. Refer to the Sheet Metal Section of this specification for requirements of flexible duct connections.
 6. Piping found to have water hammer or other objectionable vibration or noise which cannot be eliminated by proper grading or other natural means shall be braced, trapped, hung with vibration isolation hangers, equipped with air chambers or mechanical shock absorbers, flexible pipe connectors, or otherwise silenced using means as approved by the Architect.
 7. Motor driven equipment which is to be isolated shall have motor mounted on the isolated equipment or shall have motor, equipment and drive mounted on a common base.

8. The Contractor shall not install any equipment, piping or conduit which makes rigid contact with the "building" unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.
9. Isolation mounting deflection shall be (minimum) as specified or scheduled on drawings.
10. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.
11. Bring to the Architect's attention, prior to installation, any conflicts with other trades that will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
12. Bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.
13. Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.
14. Correct, at no additional cost, all installations which are deemed defective in workmanship or materials.

3.2 EQUIPMENT ISOLATION INSTALLATION

- A. Equipment shall be isolated and restrained as per the vibration isolation schedule at the end of this Section.
- B. Place floor mounted equipment on 4" high concrete housekeeping pads (unless detailed otherwise) properly doweled or expansion shielded to the deck to meet acceleration criteria. Anchor isolators and/or bases to housekeeping pads. Housekeeping pad concrete work shall be by Division 3. Housekeeping pads shall be sized to have a minimum of 6" of clearance all around the equipment or 12 bolt diameters, whichever is greater.
- C. Additional Requirements
 1. The minimum operating clearance under inertia bases shall be 2".
 2. The minimum operating clearance under other bases shall be 1".
 3. All bases shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the equipment, isolators and restraints.
 4. The isolators shall be installed without raising the equipment.
 5. After the entire installation is complete, and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. The blocks shall be barely free and shall be removed. Remove all debris from beneath the equipment and verify that there are not short circuits of the isolation. The equipment shall be free in all directions.
 6. Install equipment with flexibility in wiring.

3.3 PIPING AND DUCTWORK ISOLATION INSTALLATION

- A. Isolate piping and ductwork outside shafts connected to rotating or reciprocating equipment and pressure reducing stations as follows:
 - 1. All water piping in mechanical rooms.
 - 2. Water piping within 50'-0" or 100 pipe diameters (whichever is greater) from connected isolated equipment.
- B. The isolators shall be installed with the hanger box hung as closely as possible (without direct contact) to the structure.
- C. The isolators shall be suspended from substantial structural members sized for a maximum deflection of L/360 at mid span, not from slab diaphragm, unless specifically permitted by the structural engineer.
- D. Hanger rods shall not short circuit the hanger box.
- E. Horizontal suspended water piping 1 1/4" to 2" shall be suspended by Type E isolators with a minimum 3/8" deflection. Water pipe larger than 2" shall be supported by Type F isolators with a minimum 0.75" deflection or same deflection as equipment for the first (3) locations nearest equipment, whichever is greater.
 - 1. Type L isolators may be substituted for the above.
 - 2. Horizontal floor and roof supported pipe shall be the same as above except use isolators Type D and Type A, respectively.
- F. Ductwork shall be supported by Type C isolators with a minimum 0.75" deflection.
- G. Vertical riser pipe supports, where required, under 2" diameter shall utilize Type H isolation.
- H. Vertical riser guides, where required, shall avoid direct contact of piping with the building.
- I. Pipe anchors or guides, where required, shall utilize Type K isolators.
- J. Riser sway supports, where required, shall utilize (2) neoprene elements (Type G or H) to accommodate tension and compression forces.
- K. Install Type FC-1 (FC-4 for refrigerant piping) flexible connectors at all connections of pipe to isolated equipment such as pumps, as shown on the drawings.
- L. Install FC-2, FC-3 or FC-4 type connectors only at locations which exceed temperature or service (such as gas, fuel oil, or refrigerant) limitations of FC-1.
- M. For compressed air or vacuum piping, provide (2) flexible connectors Type FC-2 90° to each other in the compressor discharge piping to the receiver. When the receiver is remote from the compressor, isolate the piping between the compressor and receiver with Type C isolators

having 3/8" deflection. The receiver shall be isolated with Type D isolators having 3/8" deflectors.

- N. Pipe extension and alignment connectors: Provide Type FC-2 connectors at riser take-offs, cooling and heating coils and elsewhere as required to accommodate thermal expansion and mis-alignment.

3.4 SEISMIC RESTRAINTS INSTALLATION

- A. All floor mounted equipment, whether isolated or not, shall be bolted or welded to the structure to allow for required acceleration. Bolt points, diameter of inserts, imbedment depth and weld length as shown on approved submittal drawings shall be followed in all respects.
- B. All suspended equipment shall be 2-point or 4-point independently braced with Type III restraints, installed taut for non-isolated equipment, such as piping or ductwork and slack with 1/2" cable deflection for isolated equipment. Note: Stiffeners for support rods may be required, certifications shall clearly delineate when such stiffening is required or not.
 - 1. Piping Bracing: Schedule 10 thru 40 welded, screwed, flanged or grooved; 40'-0" maximum transversely, 80'-0" maximum longitudinally, and within 4'-0" each change of direction. No- hub piping shall be at 10'-0" intervals or 40'-0" if 1.0 g couplings are used.
 - 2. Ductwork Bracing: 30'-0" maximum, transversely, 60'-0" maximum longitudinally, and within 4'-0" of each change of direction.
- C. Seismic restraints are not required:
 - 1. Only when explicitly permitted by the code. These permitted exceptions shall be detailed clearly on the first page of the seismic submittal.
- D. Where base anchoring of equipment is insufficient to resist seismic forces, restraints such as Type III shall be located above the unit's center of gravity to resist "G" forces.
- E. Note: Vertically mounted tanks and upblast tubular centrifugal fans may require this additional restraint.
- F. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:
 - 1. Upper flanges of structural beams.
 - 2. Upper truss chords in bar joists.
 - 3. Cast-in-place inserts or drilled and shielded inserts in concrete structures.
- G. Chimneys and stacks passing through floors are to be bolted at each floor level or secured above and below each floor with riser clamps or approved vibration isolation systems with seismic restraints.

- H. Chimneys and stacks running horizontally to be braced every 30 ft (9 m) with Type III restraining system.
- I. Non-Isolated Equipment Installation
 - 1. All ceiling suspended pipe and duct not excluded by distance from structure allowances.
 - a. Restraint Type III or V.
 - 2. All ceiling suspended equipment including, but not limited to, fans, heat pumps, unit heaters, cabinet unit heaters, etc.
 - a. Restraint Type III or V. (If equipment is rigidly attached to duct on one side, they shall be considered ductwork.)
 - 3. Suspended ceilings containing diffusers and light fixtures may be considered as meeting seismic zone requirements. In which case, earthquake clips or other approved means of positive attachment shall secure fixture to T-bar structure.
 - 4. All floor or wall mounted equipment and tanks.
 - a. Restraint Type III or V.
 - 5. Roof (curb) mounted AC, H&V units, or fans to be mounted on seismically rated curbs.
 - a. Base Type B-4.
- J. Inspection
 - 1. On completion of installation of all vibration isolation and seismic restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.
 - 2. Provide all special inspections in accordance with IBC and as specified herein.
 - a. Continuous inspection: The full-time observation of work by an approved special inspector pursuant to IBC. The following pieces of equipment require these inspections:
 - 1) All equipment using combustible or toxic energy sources.
 - 2) All electric motors and motor control centers.
 - 3) Reciprocating and rotating type machinery.

- 4) Pipe.
 - 5) Tanks, heat exchangers & pressure vessels.
 - 6) Ductwork.
- b. Periodic inspection: Provide intermittent observation of work by an approved special inspector of the following pieces of equipment in compliance with IBC.
- 1) All smoke control systems during construction & prior to concealment for leakage testing.
 - 2) Isolator units for seismic isolation system.
 - 3) All flammable, combustible and highly toxic piping and their associated mechanical systems.
 - 4) All ductwork containing hazardous materials.
- c. After all inspections a written report shall be provided.

3.5 INSTALLATION INSTRUCTIONS

- A. Adjust all base and piping isolators as required to prevent stress transfer to equipment.
- B. Set steel bases for 1" clearance between housekeeping pad and base. Set concrete inertia bases for 2" clearance. Adjust equipment level.
- C. Position equipment, structural base and concrete base on blocks or wedges at proper operating height.
- D. Provide all equipment and provide operating load conditions before transferring base isolation loads to springs and removing wedges.
- E. Install inertia bases of type and thickness, with isolators of type and static deflection indicated.
- F. Provide isolators as specified and install in accordance with the manufacturers recommendations. Seismic restraints shall not be installed until isolators are adjusted and equipment height is finalized.
- G. Provide forms for 4" high housekeeping pads under all floor mounted equipment, including those with inertia blocks. Provide necessary reinforcing.
- H. Install equipment with flexibility in wiring connection.
- I. Verify all installed isolators and mounting system permit equipment motion in all directions.
- J. Adjust or provide additional resilient restraints to flexibly limit lateral motion to 1/4" during start-up of equipment.

- K. Before start-up, clean out all foreign matter between bases and equipment to prevent short circuit.
- L. Install flexible pipe connectors on pipe connected to equipment supported by vibration isolation. Hook up piping to equipment and mains with spool pieces. After completion of pressure testing but prior to start-up, remove spool pieces and install flexible pipe connectors. Identify spool pieces as to equipment served and either entering or leaving.
- M. Provide seismic displacement joints for all piping, ductwork and conduits crossing building expansion joints or building seismic joints.

3.6 CERTIFICATION

- A. Upon completion of installation of all vibration isolation devices and seismic restraints, the Mechanical Contractor shall hire an independent Seismic Professional Engineer to visit the site, inspect the completed project and certify in writing to the Architect that all systems are installed properly, or require correction.

END OF SECTION