

## **SECTION 23 05 48 - VIBRATION ISOLATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS:**

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 01 00, "Mechanical General Provisions", govern this Section.

#### **1.2 DESCRIPTION OF WORK:**

- A. Work Included: Provide vibration isolation supports for all equipment, piping and ductwork as may be required to prevent transmission of vibration and noise to the building structure. Expected noise levels in various parts of the building shall conform to noise criteria recommendations as set forth in the ASHRAE 1987 HVAC Systems and Applications, Chapter 52, Page 52.4. The lowest of the range of NC criteria curves shall apply. It shall be the Contractors responsibility to select and install vibration isolators which will enable the noise criteria standards to be met to the extent that the noise can be controlled by vibration isolators.

#### **1.3 QUALITY ASSURANCE:**

- A. General: Except as otherwise indicated, obtain all vibration isolation materials from a single manufacturer.
- B. Supervision: Manufacturer shall provide technical supervision of the installation of support isolation units produced by him and of associated inertia bases.
- C. Acceptable Manufacturers: Provide products complying with these specifications and produced by one of the following:
  - 1. Amber/Booth Company, Inc.
  - 2. Korfund Dynamics Corporation.
  - 3. Mason Industries.
  - 4. Metraflex, Inc.
- D. Manufacturer Certification: Where vibration isolation support units are indicated for a minimum static deflection, provide manufacturer's certification that units have been tested and comply with the indicated requirements.

#### **1.4 SUBMITTALS:**

- A. Shop Drawing submittals shall include, but not be limited to, the following:
  - 1. A complete listing of proposed types of isolators for each specified application, including size and deflection information.
  - 2. Selection calculations for all isolators with size, type and deflection noted.
  - 3. Vertical isolation riser diagrams with expansion/contraction calculations.
  - 4. Cut sheets for each isolator type to be utilized on the project.
  - 5. A clearly outlined procedure for installing and adjusting all isolators.
  - 6. Cut sheets on all furnished bases and frames.
  - 7. Cut sheets on all flexible connectors and application data as required.
  - 8. Additional information as specified in Section 23 01 00.

#### **1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:**

- A. Deliver vibration isolation materials in factory-fabricated water-resistant wrapping.
- B. Handle vibration isolation materials carefully to avoid damage to material component, enclosure and finish.
- C. Store vibration isolation materials in a clean, dry space and protect from the weather.

### **PART 2 - PRODUCTS**

## 2.1 TECHNICAL REQUIREMENTS:

- A. Deflections indicated are minimums and it shall be the responsibility of the isolation manufacturer to determine the amount of spring deflection required for each isolator to achieve optimum performance, prevent the transmission of objectionable vibration and meet the noise criteria referenced herein.
- B. Spring type vibration isolators shall be used for all equipment driven by motors of 3 hp and larger, unless otherwise noted. Equipment driven by motors 2 hp and smaller shall be isolated by means of elastomeric mounts or hangers properly sized for 1/2" deflection, unless noted otherwise.
- C. All spring isolators shall be completely stable in operation and shall be designed for not less than 30% reserve deflection beyond actual operating conditions. Spring isolators shall be horizontally stable and designed for a minimum  $k_x/k_y$  ratio (horizontal to vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches).
- D. All elastomeric isolators and isolator components shall be of neoprene or high quality synthetic rubber with antioxidant additives and shall be sized for a maximum load of 60 psi and a rating of 40 durometers.
- E. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion. Steel components shall be cleaned and painted with industrial grade enamel. All nuts, bolts, and washers shall be zinc-electroplated. Structural steel bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.
- F. All isolators exposed to the weather shall have steel parts PVC coated, hot dipped galvanized or be of stainless steel. Aluminum components [shall be etched and painted with industrial grade enamel.]
- G. Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind loads of 50 pounds/square foot applied to any exposed surface of the isolated equipment. Where isolators do not meet this requirements, stainless steel tie down cables shall be provided.
- H. Equipment subjected to excessive horizontal air thrust shall be furnished with isolated thrust resisters to limit displacement to 1/4".
- I. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating clearance is 2" or less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.
- J. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.
- K. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".
- L. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

## 2.2 ISOLATOR TYPES:

- A. General: Isolator types shall be one or more of the following as listed under Paragraph 2.04, "Equipment Isolation". Model numbers of Amber/Booth products are included for identification. Products of other specified manufacturers are acceptable provided they comply with all of the requirements of the specification.
- B. Floor Mounts:
  - 1. Type SW: An adjustable, free-standing, open-spring mounting with combination leveling and equipment fastening bolt. The spring shall be welded to the spring mounting base plate and compression plate for stability. The isolator shall be designed for a minimum  $k_x/k_y$  (horizontal-

- to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4" and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the base plate. Nuts, adjusting bolts and washers shall be zinc-electroplated to prevent corrosion.
2. Type RSW: An adjustable, free-standing, enclosed spring mounting for integral mounting in a Type CPF base. The isolator shall be designed for a minimum  $k_x/k_y$  (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4" and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the spring base plate. Nuts, bolts and washers shall be zinc electroplated to prevent corrosion. Isolators shall have a steel semihousing with built-in height saving bracket for recessing into a concrete pouring form (CPF) concrete inertia block for side access. Brackets for use with isolators having 2.5 deflection or greater shall be of the precompression type to limit exposed bolt length.
  3. Type XL: An aluminum-housed, adjustable spring mounting having telescoping top and bottom sections separated by resilient elastomeric inserts to limit horizontal motion. Steel or cast iron housings may be used if they are hot-dip galvanized after fabrication. The isolator shall be designed for a minimum  $k_x/k_y$  (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4" and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the base plate. Nuts, adjusting bolts, and washers shall be zinc-electroplated to prevent corrosion.
  4. Type RVD: An elastomeric mounting having a steel base plate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric material. Mountings shall be designed for approximately 1/2" deflection.
  5. Type SP-NRE: A pad type mounting consisting of two layers of 3/8" thick ribbed or waffled elastomeric pads bonded to a 16 gauge galvanized steel separator plate. Pads shall be sized for approximately 20 to 40 psi load and a deflection of 0.12" to 0.16".
  6. Type CT: An adjustable, open-spring isolator having one or more coil springs attached to the top compression plate and a base plate. The isolator shall be designed for a minimum  $k_x/k_y$  (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4" and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the base plate. Nuts, adjusting bolts and washers shall be zinc-electroplated to prevent corrosion. The spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolated restraining bolts which shall not be engaged during normal operation shall connect the top plate and lower housing to prevent the isolated equipment from rising when drained of water.
  7. Type TRK: A set (two or more) of spring thrust resisting assemblies each consisting of a coil spring, spring retainer, isolation washer, steel washer, angle mounting brackets, and neoprene tubing for isolating thrust resister rod at fan discharge or suction.

C. Hangers:

1. Type BS: A spring hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation, coil spring, spring retainers, neoprene impregnated fabric washer and steel washer.
2. Type BSR: A combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation, one inch (1") deflection coil spring, spring retainers and elastomeric mounting designed for approximately 1/2" deflection, 1-1/2" total deflection.
3. Type PBS: A spring hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to

the spring after installation, a coil spring, spring retainers, neoprene impregnated fabric washer and steel washer.

4. Type PBSR: A combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation, with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation, a 2" deflection coil spring, spring retainers and elastomeric mounting designed for approximately 1/2" deflection, 2-1/2" total deflection.
5. Type BRD: An elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation and an elastomeric isolation element. The elements shall be designed for approximately 1/2" deflection.

D. Base Types:

1. Type HKP: A concrete equipment housekeeping pad as specified in Section 230300, "Basic Materials and Methods".
2. Type CPF: A concrete inertia base, consisting of perimeter steel concrete pouring form (CPF), with reinforcing bars and isolators welded in place. The perimeter steel members shall have a minimum depth of 1/12 of the longest span, but not less than 6" deep. The base shall be sized with a minimum overlap of 4" around the base of the equipment and, in the case of belt-driven equipment, 4" beyond the end of the drive shaft. Fan bases are to be supplied with NEMA standard motor slide rails. The bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space. The CPF base shall be installed over a concrete equipment (housekeeping) pad as specified elsewhere in Division 23.
3. Type RTIR: An extended aluminum rail base for rooftop air conditioning units consisting of a pair of weatherproofed aluminum rails for fastening to equipment and to the roof curb incorporating wind restraints and a continuous air and water seal which is protected from accidental puncture and direct sunlight by an aluminum weather shield. Rails shall incorporate nonadjustable Type SW spring isolators properly spaced around perimeter and sized for one inch (1") deflection. To prevent leaks, rails shall be factory-assembled (to the limits of freight carriers) and shipped as a one-piece unit.
4. Type SR: A set (two or more) of structural steel channel or angle rails to which isolators are rigidly attached. Bolt holes shall be provided for bolting equipment to the rails. Isolators shall be spaced along the rails on sufficiently close centers to limit deflection of the rail to 1/360 of the unsupported span. Isolators shall be Type SW with vertical limit stops or Type RVD as specified.
5. Type CURB - An equipment roof curb as specified in Section 23 03 00.

2.3 FLEXIBLE PIPE CONNECTIONS:

- A. General: Provide full line size flexible connectors at the suction and discharge connection to each **[chilled water and heating hot water pump]** to each **[domestic water]** pumping system **[in the Central Plant]**, on connections to air compressors**[, vacuum pumps]** and at other locations as shown on the Drawings. All connectors shall be suitable for use at the pressure and temperature encountered at point of operation. End fitting of connectors shall conform to pipe fitting types specified elsewhere.

B. Water Service:

1. Flanged (2-1/2" and Larger), Amber/Booth Type 2800 - a flanged spherical arch rubber expansion joint constructed of molded reinforced neoprene with integral steel floating flanges, suitable for pressures up to 220 psi (4 to 1 safety factor) and temperatures up to **[220°F]**. Connectors shall have minimum movement capability of compression, 1/2" lateral and 15 degrees angular. Spring loaded control units shall be furnished for sizes up through 8" to limit thrust elongation to 3/8". For 10" and larger the control rods shall be fitted with neoprene bushings for isolation.
2. Threaded (2" and Smaller), Amber/Booth Type 2655 - a double spherical rubber hose connector, minimum 8" long, constructed of molded neoprene, nylon cord reinforced, with female pipe

unions at each end. Connectors shall have a minimum movement capability of 7/8" compression, 7/8" lateral, 1/4" extension and 45 degrees angular. Connectors shall be suitable for a maximum working pressure (4 to 1 safety factor) of 150 psi and 220°F.

3. **Grooved, Victaulic Style 77 Coupling: Use at least three couplings in series between vibration source and piping main headers, for vibration isolation. Use more than three couplings if necessary to obtain required total minimum movement. Install per Victaulic Publication TS-5000.]**

C. Steam and Condensate Service:

1. Flanged (2-1/2" and Larger), Amber/Booth Type SS-FP - a flanged metal hose connector constructed of stainless steel hose and braid with carbon steel plate flanges. Minimum lengths shall conform to the following table:

4" and smaller	9" long
5" and 6" diameter	11" long
8" diameter	12" long
10" diameter	13" long

2. Threaded (2" and smaller), Amber/Booth Type SS-PM - a metal hose connection constructed of stainless steel hose and braid with carbon steel NPT threaded end fittings. Minimum lengths shall conform to the following:
  - a. 1-1/2" diameter (and smaller) x 10" long.
  - b. 2" x 12" long.
  - c. 2-1/2" x 13" long.

D. Air Compressor [and Vacuum Pump] Service:

1. Flanged, Type SS-FP (Special): A flanged metal hose connector constructed of stainless steel hose and braid with carbon steel plate flanges. Connector shall be double braided with a minimum live length equal to four times the diameter. Connector shall be installed with the long axis perpendicular to the motion to be absorbed.
2. Threaded, Type SS-PM (Special): A metal hose connector constructed of stainless steel hose and braid with carbon steel NPT threaded end fittings. Connector shall be double braided and have a minimum live length equal to four times the diameter. Connector shall be installed with the long axis perpendicular to the motion to be absorbed.

2.4 EQUIPMENT ISOLATION:

[verify requirements refer to chart in GUIDE spec book]

<u>ISOLATOR EQUIPMENT</u>	<u>MINIMUM TYPE</u>	<u>BASE DEFLECTION</u>	<u>TYPE</u>
<b>Air Handling Units [*]</b>			
Floor Mounted:			
Up to 15 hp	[SW] [XL]	[2.0] [1.0]	HKP
20 hp & Over	[SW] [XL]	[2.5] [2.0]	HKP
Suspended:			
Up to 15 hp	[PBSR] [BSR]	[2.0] [1.5]	----
20 hp & Over	PBSR	[2.5] [2.0]	----
Roof Mounted:	SW	1.0	RTIR
<b>Fan Coil Units [and fan-powered HVAC Terminal units] (Suspended)</b>			
	BRD	0.5	----

Ceiling Mounted A/C Units	BRD	0.5	----
Electronic Air Cleaners	BRD	0.5	----
Fans			
Centrifugal - Floor Mounted			
Up to 15 hp	[RSW] [SW]	[2.5] [1.5]	HKP
20 hp & Over	[RSW] [SW]	2.5	CPF/HKP
Centrifugal - Suspended			
Up to 15 hp	[PBSR] [BSR]	[2.0] [1.5]	----
20 hp & Over	PBSR	[2.5] [2.0]	----
Axial Flow - Floor Mounted			
Up to 15 hp	[SW] [XL]	[1.5] [1.0]	HKP
20 hp & Over	[RSW] [SW]	[3.5] [2.0]	HKP
Axial Flow - Suspended			
Up to 15 hp	[PBSR] [BSR]	[1.5] [1.0]	----
20 hp & Over	PBSR	[2.5] [2.0]	----
Roof Mounted Fans	Isolators furnished with equipment		
In-line Pumps	None	----	----
Floor Mounted HVAC Pumps**			
Up to 5 hp	----	----	HKP
7-1/2 hp & Over	----	----	HKP
Packaged Domestic Water Pumping System	SP-NRE	0.15	HKP
Floor Mounted HVAC Pumps***			
Up to 5 hp	RSW	1.0	CPF/HKP
7-1/2 hp & Over	RSW	[2.0] [1.5]	CPF/HKP
Floor Mounted Plumbing <b>[and Fire Protection]</b> Pumps	None	----	HKP
Air Compressors	RSW****	1.5	HKP
Air Dryer(s)	SP-NRE	0.15	HKP
<b>[Medical] [Laboratory]</b> Air Compressor(s)	SP-NRE	0.15	HKP
<b>[Medical] [Laboratory]</b> Vacuum Pump(s)	SP-NRE	0.15	HKP
Refrigeration Units			
Hermetic Centrifugals	SP-NRE	0.15	HKP
Reciprocating Centrifugals	SP-NRE	0.15	HKP
Boilers	----	----	HKP
Cooling Towers			

Up to 500 Tons	CT	3.0	<b>[Structural Steel Base by G.C. Refer to Structural Drawings.]</b>
Over 500 Tons	CT	4.5	

Air Cooled Condensing Units

Roof Mounted			
Up to 5 Tons	SP-NRE	0.15	CURB
7-1/2 Tons to 20 Tons	CT	1.0	CURB

Computer Room A/C Units ----- Direct mount with neoprene gasket

Water Heaters ----- HKP

- \* SP-NRE with 0.15" deflection for internally isolated air handling units in the mechanical rooms.
- \*\* For pumps installed in the Central Plant.
- \*\*\* For pumps installed in the Mechanical Penthouse.
- \*\*\*\* SP-NRE with 0.15" deflection for air compressors installed in the Central Plant.

2.5 PIPING ISOLATION:

[Select one of the following]

A. **General:** All pumped water and refrigerant piping 1-1/2" and larger within mechanical equipment rooms and 2" and larger outside mechanical equipment rooms shall be isolated by means of spring type vibration isolation hangers or floor mounts as may be required to create the effect of a completely floating system. Steam piping 1-1/2" and larger connected to isolated equipment shall be isolated for a distance of 50'. Isolators for equipment are described elsewhere in this specification. It shall be the responsibility of the vibration isolation manufacturer to coordinate the selection of piping supports with equipment supports to provide for a carefully engineered isolation system designed to accommodate expansion and contraction while isolating and supporting the pipe and equipment.]

[or]

B. **General:** Isolate all pumped water, steam condensate and refrigerant piping 1-1/2" and larger within each mechanical equipment room, and for a distance of not less than 50' from motor driven equipment to which the piping is connected. Use type PBS isolators for the first two hangers adjacent to isolated equipment and for all piping 8" and larger. Use Type BS isolators for all other hangers. Floor supported piping shall be isolated with Type SW isolators. The first two isolators adjacent to equipment shall have a deflection equal to the equipment isolation, but not to exceed 2.0"; the remaining isolators shall be sized for 3/4" deflection. Install full line size flexible pipe connectors at the suction and discharge connection of each pump and at the inlet and outlet of each condenser and chiller.]

C. **Riser Diagrams:** The vibration isolation manufacturer shall prepare and submit riser diagrams for approval. These diagrams shall show anticipated vertical expansion and contraction of various segments of the piping and spring deflection changes. Wall sleeves for take-offs from risers shall be sized for insulation O.D. plus two times these anticipated movements to prevent binding. If flexible connectors or expansion loops to relieve stress are required in the riser system, they shall be furnished whether shown or not at no expense to the Owner or Engineer. Type and design shall be submitted to the Engineer for approval. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the design proposed when installed in accordance with submittals and these specifications.

D. Diesel engine exhaust piping and mufflers shall be isolated using spring isolators sized for twice the calculated system expansion.

E. Condenser water system shall be rigidly supported with flexible connections as shown.

- F. Steam and steam condensate piping shall be rigidly supported on roller supports with rigid anchors to structure where shown or required.
- G. All horizontal runs of refrigerant piping 1-1/4" and smaller within the building shall be suspended using Amber/Booth Type HRD-1-A or approved equal rubber-in-shear isolators to prevent compressor noise from being transmitted to the building construction.]
- H. Domestic water[, laboratory gas piping] [,medical gas piping] and fire protection systems shall be rigidly supported with flexible connections as shown or specified.]
- I. Expansion loops and flexible connectors shown on the plans may be omitted provided analysis shows that the piping and equipment connections are not overstressed by their removal. Calculations showing the resultant stress shall be submitted to the Engineer for approval prior to omission of loops and connectors.
- J. Technical Requirements:
  - 1. Hangers for horizontal piping shall be installed at regular intervals as specified in Section 230300, "Basic Materials and Methods". Isolated pipe risers up to 16" shall be supported at intervals of every third floor of the building and every second floor for risers 18" and larger.
  - 2. The first two piping supports away from any given piece of equipment to which piping is connected shall be selected for an operating spring deflection equal to that specified for the equipment isolators, but not to exceed 2". All other supports for horizontal piping shall have a minimum operating deflection of 3/4" with capability of 50% additional travel-to-solid. To prevent excessive transfer of piping load from floor to floor, all riser support springs shall have a deflection capability of four times the expansion or contraction to be accommodated by the support with the additional run-out capability to absorb the movement.
  - 3. **Provide Amber/Booth Type 301 or equal acoustic seals where isolated piping passes through nonfire rated wall, ceiling or floor openings from equipment rooms into adjoining occupied spaces and for all piping in [\_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_]. The acoustic seals shall consist of an S-shaped molded synthetic rubber seal attached with stainless steel clamps to the pipe wall sleeves and to carrier piping. The wall sleeves shall be two pipe sizes larger than the insulated carrier piping.**
- K. Isolator Types: Piping system vibration isolators shall be as follows:
  - 1. Type PBS for first two hangers in horizontal piping adjacent to isolated equipment and for all hangers on 8" and larger pipe, except the first two hanger points adjacent to riser shall be Type BS.
  - 2. Type BS for remaining hangers in horizontal piping.
  - 3. Type SW for pipe risers. Isolator base plates shall be provided with holes for bolting and isolation grommets.
  - 4. Type SW for floor supports except Type CT for first floor support adjacent to equipment isolated on CT isolators.

## 2.6 DUCTWORK ISOLATION:

- A. General: [Rigidly support all ductwork with flexible duct connections at equipment.] [Isolate all high pressure ductwork within each equipment room and to a minimum of 50' from fan with Type BS hangers or SW floor supports, properly sized for 3/4" deflection.]

## **PART 3 - EXECUTION**

### 3.1 PERFORMANCE OF ISOLATORS:

- A. General: Comply with the minimum static deflections recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers including the definitions of critical and noncritical locations, for the selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's instructions for selection and application of vibration isolation materials and units.

### 3.2 INSTALLATION:



- A. General: Except as otherwise indicated, comply with manufacturer's instructions for the installation and load application of vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections, do not bottom out under loading, and are not short circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.
- B. Secure Attachment: Anchor and attach units to substrate and equipment for secure operation, to prevent displacement by normal forces.
- C. Adjustment: Adjust leveling devices to distribute loading uniformly onto isolators. Shim units where leveling devices cannot be used to distribute loading properly.
- D. Base Frames: Install inertia base frames on isolator units so a 2" (minimum) clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation.
- E. Isolation Hangers: Locate isolation hangers as near the overhead support structure as possible.
- F. Welding: Weld riser isolator units in place to prevent displacement from loading and operations.
- G. Airtight Connections: Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

### 3.3 EXAMINATION OF RELATED WORK:

- A. Examination and Reporting: Installer of vibration isolation work shall observe the installation of other work related to and connected to vibration isolation work. After completion of other related work (but before equipment start up), he shall furnish a written report to the Contractor, with copy to the Engineer, listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to, the following:
  - 1. Equipment installation (performed as work of other Sections) on vibration isolators.
  - 2. Piping connections including flexible connections.
  - 3. Ductwork connections including provisions for flexible connections.
  - 4. Passage of piping which is to be isolated through walls and floors.
- B. Correction and Start-up: Do not start up equipment until inadequacies have been corrected in a manner acceptable to the vibration isolation installer.

### 3.4 DEFLECTION MEASUREMENTS:

- A. Report: Upon completion of vibration isolation work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Submit all reports to the Engineer for final review.

### 3.5 FIELD SERVICES:

- A. Representative: The isolation materials manufacturer shall provide the services of an authorized representative to supervise and ensure correct installation of isolators and sound attenuation materials and proper adjustment of the isolators after installation. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the **[authorized manufacturers representative] [Contractor shall provide the services of a qualified Vibration/Noise Consultant who]** shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the vibration isolation installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report and shall be corrected by the Contractor and accepted in writing by the **[authorized manufacturers representative] [Contractor's qualified Vibration/Noise Consultant]**. Should any noise or vibration be objectionable to the Owner, Architect or Engineer, the **[Contractor shall provide the services of a qualified] [Contractor's qualified] Vibration/Noise Consultant** shall provide a field instrumentation test and at no cost to the Owner or Architect/Engineer. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.

### 3.6 EQUAL LOADING:

- A. General: All equipment installed on vibration isolation mountings shall be level after load is applied. Further, vibration isolation mountings shall be selected and installed to compensate for unequal

loading. Spring isolators with coils touching during equipment start up or operation will not be acceptable.

**END OF SECTION 23 05 48**