

## **SECTION 230710 - SEISMIC RESTRAINT FOR MECHANICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 DEFINITIONS AND REFERENCE STANDARDS**

- A. Seismically restrain the mechanical equipment and systems listed in this Specification referenced from Structural plans. The following criteria are applicable to this project.
  - 1. Building Occupancy Category: **IV**
  - 2. Soil Site Class Category: **C**
  - 3. Component Importance Factor (Ip): **1.5**
  - 4. Design Spectral Response Acceleration (SDS): SDS = 0.138, SD1 = 0.048
  - 5. Site Coefficient : short period - 1.2, long period – 1.5
  - 6. Mapped Spectral Acceleration (Ss): SS = 0.159, S1 = 0.048
  - 7. Seismic Design Category: **A**
  - 8. Design Coefficient Table for basic seismic force resisting systems
  - 9. The total height of the structure (h) and the height of the system to be restrained within the structure (z) shall be determined by the Contractor.

#### **1.2 INSTALLATION GUIDELINES**

- A. Provide work in compliance with the following guidelines:
  - 1. Cooper B-Line SRS-02 – Seismic Restraints: Multi-Directional Bracing for Mechanical Piping Systems.
  - 2. ANSI/NFPA 70 – National Fire Protection Association (National Electrical Code).
  - 3. NFPA 13 – Installation of Sprinkler Systems.
  - 4. ASME B31.
  - 5. National Uniform Seismic Installation Guidelines (NUSIG).
  - 6. New York State Building Code.

#### **1.3 SYSTEM DESCRIPTION:**

- A. General Requirements: The requirements for the seismic protection measures described in the Specification shall be applied to the mechanical equipment and systems listed below.

- B. Mechanical Equipment: Mechanical equipment to be seismically protected shall include the following items:
1. Boilers
  2. Expansion and Air separators
  3. Valve and Fittings for Piping.
  4. VRF Fan coils and Air Handling Units.
  5. Pumps with motors
  6. Ductwork
  7. Unit Heaters
  8. Gas Fired Radiant Heaters
  9. HVLS Fans in Apparatus Bay
  10. Exhaust and Return Fans
- C. Mechanical Systems: The following mechanical systems shall be installed and shall be seismically protected in accordance with this specification.
1. All new piping inside the building except as specifically stated below under "Items not covered by this section".
- D. Items not covered in this section:
1. Seismic Restraints are not required for the following items:
    - a. Piping in boiler and mechanical equipment room less than 1-1/4 inch inside diameter.
    - b. All other piping less than 2-1/2 in. diameter.
    - c. Rectangular air handling ducts less than 6 square feet in cross sectional area.
    - d. Round air handling ducts less than 28 in. in diameter.
    - e. Piping suspended by individual hangers 12 inches or less in length from top of pipe to bottom of the supporting structural member where the hanger is attached, except as noted below.
    - f. Ducts suspended by hangers 12 inches or less in length from the top of duct to bottom of the supporting structural member, except as noted.
  2. In exemptions (e) and (f), all hangers shall meet the length requirements. If the length requirement is exceeded by one hanger in the run, the entire run shall be braced. Interior piping and ducts not listed above shall be seismically protected in accordance with the provisions of this specification.

#### 1.4 EQUIPMENT REQUIREMENTS:

- A. Non-rigid or Flexibly-Mounted Equipment: Non-rigidly mounted equipment shall be constructed and assembled to resist a horizontal lateral force of two times the

operating weight of the equipment at the vertical center of gravity of the equipment.

1.5 SUBMITTALS:

- A. Product Data: Include Seismic Rating Curve for each seismically rated isolator or restraint component.
- B. Samples: The contractor shall submit samples of specified seismic snubber devices upon request of the engineer for approval.
- C. Shop Drawings shall include the following:
  - 1. Design Calculations: Calculate requirements for selecting seismically rated vibration isolators and seismic restraints. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years experience in the design of seismic restraints.
  - 2. Vibration Isolation Bases: Dimensional drawings including anchorage and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads.
  - 3. Seismic-Restraint Details: Detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include ratings for loads.
  - 4. Equipment Manufacturer Seismic Qualification Certification: The Equipment Manufacturer must submit certification that each piece of provided equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
    - a. Basis for Certification: Indicate whether the "withstand" certification is based on actual test of assembled components or on calculations.
    - b. Indicate the equipment is certified to be durable enough to:
      - i. structurally resist the design forces and/or
      - ii. will remain functional after the seismic event.
  - 5. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 6. Detailed description of the assumed equipment anchorage devices on which the certification is based.

1.6 **WORK FURNISHED BUT NOT INSTALLED**

- A. The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the mechanical equipment, piping, or ductwork.

#### 1.7 **COORDINATION**

- A. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the project engineer.
- B. Coordinate with seismic restraint manufacturer to locate and size structural supports underneath seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment).

#### 1.8 **DESCRIPTION OF SYSTEM**

- A. It shall be understood that the requirements of this seismic restraint section are in addition to other requirements as specified elsewhere for the support and attachment of equipment and mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements of this seismic restraint section.
- B. The work under this section shall include furnishing all labor, materials, tools, appliances, and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications
- C. All seismic snubber restraint assemblies shall meet the following minimum requirements:
  - 1. The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (this does not include cable restraints).
  - 2. It shall be possible to visually inspect the resilient material for damage and allow for replacement, if necessary.
  - 3. All snubbers are to include a maximum air gap of 0.25 in (6 mm).
  - 4. Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.
  - 5. Seismic restraint capacities to be verified by an independent test laboratory or certified by a registered Professional Engineer to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:
    - a. An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.

- b. Certified be a registered Professional Engineer with at least 5 years experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE SPC171 and VISCMA 102-2007 is required.
- c. By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

## 1.9 SYSTEM DESIGN

- A. Seismic restraint manufacturer shall be responsible for the structural design of attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.
- B. The contractor shall furnish, to the seismic restraint manufacturer, a complete set of approved shop drawings of all equipment that is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, and installed operating weights of the equipment to be restrained.
- C. All piping and ductwork is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as "worst case" reaction loads for each restraint and/or anchor size.
- D. The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size of the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain the desired equipment anchor capacities.

## PART 2 - PRODUCTS

### 2.1 SOURCE OF MATERIALS

- A. All seismic snubbers and combination restraint / vibration isolation materials specified herein shall be provided by a single manufacturer to assure sole source responsibility for the proper performance of the materials used. Manufacturer is to be a member of VISCMA.
- B. Anchor types and sizes are to be per the design data as provided by the seismic restraint manufacturer.
- C. Materials and systems specified herein and detailed or scheduled on the drawings are based upon materials manufactured by Kinetics Noise Control, Inc. Materials and systems provided by other manufacturers are acceptable, provided that they meet all requirements as listed in this specification.

## 2.2 SEISMIC SNUBBER TYPES

- A. Type A, Coil Spring Isolator Incorporated Within A Ductile Iron Or Cast Aluminum Housing
  - 1. Cast iron or aluminum housings are brittle when subjected to shock loading and are therefore not approved for seismic restraint applications.
- B. Type B, Coil Spring Isolator Incorporated Within A Steel Housing
  - 1. Spring isolators shall be seismic control restrained spring isolators, incorporating a single or multiple coil spring element, having all of the characteristics of free standing coil spring isolators as specified in the vibration isolation portion of this specification. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal equipment operating conditions.
  - 2. Vibration isolators shall incorporate a steel housing and neoprene snubbing grommet system designed to limit motion to no more than 1/4 in (6 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed restraint housing. The restraining system shall be designed to withstand the seismic design forces in any lateral or vertical direction without yield or failure. Where the capacity of the anchorage hardware in concrete is inadequate for the required seismic loadings, a steel adapter base plate to allow the addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation coil spring, the load path will include a minimum 1/4 in (6 mm) thick neoprene pad.
  - 3. Spring elements shall be color coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.
  - 4. To facilitate servicing, the isolator will be designed in such a way that the coil spring element can be removed without the requirement to lift or otherwise disturb the supported equipment.
  - 5. Design Make:
    - a. Spring isolators shall be Model FHS as manufactured by Kinetics Noise Control or model SFS as manufactured by Vibro-Acoustics, or approved equal.
- C. Type C, Coil Spring Isolator Incorporated Within A Steel Housing - Chillers
  - 1. Spring isolators shall be seismic control restrained spring isolators, incorporating one or more coil spring elements, having all of the

characteristics of free standing coil spring isolators per the vibration isolation section of this specification, for equipment which is subject to load variations and/or large external forces. Isolators shall consist of one or more laterally stable steel coil springs assembled into fabricated welded steel housings designed to limit movement of the supported equipment in all directions.

2. Housing assembly shall be made of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom load plate with internal non-skid isolation pads and holes for anchoring the housing to the supporting structure. Housing shall be hot dipped galvanized for outdoor corrosion resistance. Housing shall be designed to provide a constant free and operating height within 1/8 in (3 mm).
3. The isolator housing shall be designed to withstand the project design seismic forces in all directions.
4. Coil spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Spring elements shall be color coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.
5. Design Make:
  - a. Spring isolators shall be Model FLS and FLSS as manufactured by Kinetics Noise Control, , or model SFS as manufactured by Vibro-Acoustics or approved equal.

D. Type D, Coil Spring Isolator Incorporated With Integral Seismic Restraint

1. Spring isolators shall be single or multiple coil spring elements which have all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of this specification, incorporating lateral and vertically restrained seismic housing assemblies. Spring elements shall be readily replaceable without the need to lift or remove the supported equipment.
2. Restraint housing shall be sized to meet or exceed the force requirements of the application and shall have the capability of accepting coil springs of various sizes, capacities, and deflections as required to meet the required isolation criteria. All spring forces shall be contained within the coil / housing assembly, and the restraint anchoring hardware shall not be exposed to spring generated forces under conditions of no seismic force. Spring element leveling adjustment shall be accessible from above and suitable for use with a conventional pneumatic or electric impact wrench.

3. Restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. Elastomeric elements shall be replaceable. Restraint shall allow 1/4 in (6 mm) free motion in any direction from the neutral position. Restraint shall have an overturning factor (ratio of effective lateral snubber height to short axis anchor spacing) of 0.33 or less to ensure optimum anchorage capacity.
4. Design Make:
  - a. Spring isolators shall be Model FMS as manufactured by Kinetics Noise Control, or model SFS as manufactured by Vibro-Acoustics or approved equal

E. Type E, All Direction Neoprene Isolator

1. Vibration Isolators shall be neoprene, molded from oil resistant compounds, designed to operate within the strain limits of the isolator so to provide the maximum isolation and longest life expectancy possible using neoprene compounds. Isolators shall include encapsulated cast-in-place top steel load transfer plate for bolting to equipment and a steel base plate with anchor holes for bolting to the supporting structure. Ductile iron or cast aluminum components are not acceptable alternatives and shall not be used due to brittleness when subjected to shock loading.
2. Isolator shall be capable of withstanding the design seismic loads in all directions with no metal-to-metal contact.
3. Isolator shall have minimum operating static deflections as shown on the project Vibration Isolation Schedule or as otherwise indicated in the project documents and shall not exceed published load capacities.
4. Design Make:
  - a. Neoprene isolators shall be Model RQ as manufactured by Kinetics Noise Control, or model NSN as manufactured by Vibro-Acoustics or approved equal.

F. Type F, Light Capacity All Direction 3-Axis External Seismic Snubber Assembly

1. Equipment shall be restrained against excessive movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.
2. Snubbers shall be of interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of 1/4 in (6 mm) in any direction.



3. Snubbers shall include a minimum 1/4 in (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Snubber shall be capable of withstanding an externally applied seismic force of up to 3,000 pounds (1360 kg.) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
4. Design Make:
  - a. Three-axis seismic snubbers shall be Model HS-5 as manufactured by Kinetics Noise Control, model SRB as manufactured by Vibro-Acoustics, or approved equal.

G. Type G, Lateral 2-Axis External Seismic Snubber Assembly

1. Equipment shall be restrained against excessive lateral movement during a seismic event by the use of 2-axis horizontal resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all horizontal directions, and additional snubbers shall be used as required by seismic design conditions.
2. Snubbers shall be of interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location to a maximum of 1/4 in" (6 mm).
3. Snubbers shall include a minimum of 1/4 in (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
4. Design Make:
  - a. Two-axis lateral seismic snubbers shall be Model HS-2 as manufactured by Kinetics Noise Control, or model SRB as manufactured by Vibro-Acoustics or approved equal.

H. Type H, Heavy Capacity All Direction 3-Axis External Seismic Snubber Assembly

1. Equipment shall be restrained against excessive vertical and horizontal movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.

2. Snubbers shall be of welded interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of 1/4 in (6 mm) in any direction.
  3. Snubbers shall include resilient neoprene pads with a minimum thickness of 1/4 in (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be capable of withstanding an externally applied seismic force of up to 10,000 pounds (4,540 kg.) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
  4. Design Make:
    - a. Three-axis seismic snubbers shall be Model HS-7 as manufactured by Kinetics Noise Control, or model SRB as manufactured by Vibro-Acoustics or approved equal.
- I. Type I, Horizontal 1-Axis External Seismic Snubber Assembly
1. Equipment shall be restrained against excessive horizontal one-axis movement during a seismic event by the use of single-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of four (4) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.
  2. Snubbers shall be of steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location in the direction of impact to a maximum of 1/4 in (6 mm).
  3. Snubbers shall include resilient neoprene pads with a minimum thickness of 1/4 in (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to eliminate any contact during normal equipment operation.
  4. Design Make:
    - a. Single-axis seismic snubbers shall be Model HS-1 as manufactured by Kinetics Noise Control, or model SRB as manufactured by Vibro-Acoustics, or approved equal.
- J. Type J, Cable Restraints for Suspended Piping and Ductwork
1. Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist project seismic loads, arranged to offer seismic restraint

capabilities for piping, ductwork, and suspended equipment in all lateral directions.

2. Building and equipment attachment brackets at each end of the cable shall be designed to permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points as required to eliminate potential for dynamic cable wear and strand breakage.
3. Restraints shall be sized to the capacity of the cable or to the capacity of the anchorage, whichever is the lesser.
4. Seismic wire rope connections shall be made using overlap wire rope "U" clips or seismically rated tool-less wedge insert lock connectors.
5. Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical 'up' forces. Braces shall be structural steel angle uniquely selected to be of sufficient strength to prevent support rod bending. Brace shall be attached to the vertical suspension rod by a series of adjustable clips. Clips shall be capable of securely locking brace to suspension rod without the need for hand tools.
6. Where clevis hanger brackets are used for seismic restraint attachment, they will be fitted with clevis internal braces to prevent buckling of the hanger brackets.
7. Design Make:
  - a. Seismic cable shall be as manufactured by Kinetics Noise Control, or approved equal.
  - b. Seismic cable building and equipment attachment brackets shall be Model KSCA, KSCU or KSCC as manufactured by Kinetics Noise Control, or model SRK as manufactured by Vibro-Acoustics, or approved equal.
  - c. Seismic cable concrete anchor bolts shall be Model KCAB Wedge, Model KCCAB Cracked Concrete, or Model KUAB Undercut, as manufactured by Kinetics Noise Control, or Seismic Anchor Bolts compliant with ACI 355.2 as manufactured by Vibro-Acoustics, or approved equal.
  - d. Seismic wire rope connectors shall be (Model KWRC - 'U' clamp) / (Model KWGC - Tool-less wedge lock) as manufactured by Kinetics Noise Control, or model SRK as manufactured by Vibro-Acoustics, or approved equal.
  - e. Seismic vertical suspension stiffener rod clips shall be Model KHRC as manufactured by Kinetics Noise Control, or model VAC as manufactured by Vibro Acoustics, or approved equal.

- f. Clevis Internal Braces shall be Model KCHB as manufactured by Kinetics Noise Control, or model SRK as manufactured by Vibro-Acoustics or approved equal.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions.
- B. Upon completion of installation of all seismic restraint materials and before start up of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers/restraints.
- C. All external utility connections to restrained equipment shall be designed to allow differential seismic motion without damage to the equipment or utility connections.
- D. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.
- E. After equipment installation is completed, adjust limit stops following manufacturer's written instructions so that they are out of contact during normal operation.
- F. Adjust snubbers according to manufacturer's written instructions.
- G. Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.
- H. Rigidly Mounted Equipment: Each item of rigid equipment shall be entirely located and rigidly attached on one side only of a building expansion joint. Piping, duct, electrical conduit, etc., which cross the expansion joint shall be provided with flexible joints that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.
- I. Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the engineer for approval prior to the beginning of the work.

### **3.2 EXECUTION**

- A. Attach piping to the trapeze per seismic restraint manufacturer's design. Install cables so they do not bend across sharp edges of adjacent equipment or building structures.

- B. Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.
- C. If mounting hole diameter exceeds bolt diameter by more than 0.125" (3mm), reduce clearance in hole with epoxy grout, flanged elastomeric bushings or welded washer.
- D. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer seismic restraint manufacturer's written instructions.

### 3.3 INSPECTION

- A. The contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.
- B. Upon completion of the installation of all seismic restraint devices herein specified, the local representative of the seismic restraint manufacturer shall, at the contractor's request, inspect the completed system and report in writing any installation errors, improperly selected snubber devices, or other fault in the system which could affect the performance of the system.
- C. The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

### 3.4 PIPING

- A. Seismically restrain all piping listed below. Use Type J Cable Restraints for all piping supported by vibration isolation hanger assemblies, including:
  - 1. Hot water, steam and chilled water piping, equal to or greater than 1 in (25 mm) in inside diameter.
  - 2. Brace remainder of piping to code requirements (IBC or TI-809-04)) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

### 3.5 DUCTWORK

- A. Seismically restrain all ductwork listed below. Use Type J Cable Restraints for all ductwork supported by vibration isolation hanger assemblies, including:
  - 1. All rectangular and oval ducts with cross sectional area equal to or greater than 6 sq. ft. (0.55 sq. meters).

2. All round ducts with diameters equal to or greater than 32 in (812 mm).
3. All trapezed Duct Work with supported weight of over 15lbs/ft
4. Brace remaining ductwork to code requirements (IBC or TI-809-04)) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

### 3.6 CONDUIT

- A. Seismically restrain all electrical conduit listed below. Use Type J Cable Restraints for all conduit supported by vibration isolation hanger assemblies, including:
  1. **All conduit weighing over 10lbs/ft.**
  2. **All trapezed conduits weighing over 10lbs/ft. including cable trays.**
- B. Seismically restrain all floor mounted electrical components weighing over 40lbs and wall or ceiling mounted components weighing over 20lbs.

**END OF SECTION**