

**CONSTRUCTION SPECIAL SPECIFICATION****SECTION 15071****SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT****PART 1 - GENERAL****1.1 REFERENCES**

- A. International Building Code, 2003.
- B. SMACNA Seismic Restraint Manual - Seismic Restraint Manual Guidelines for Mechanical Systems.

**1.2 CODE INFORMATION**

- A. Seismically restrain the mechanical equipment and systems listed in this Specification per the International Building Code, 2003 edition. The following criteria are applicable to this project.
  - 1. Seismic Use Group (Table 1604.5): II
  - 2. Site Class Category (Table 1615.1.1): D
  - 3. Design Spectral Response Acceleration (SDS, Section 1615.1.3): 0.530
  - 4. Site Coefficient (Fa, Table 1615.1.2(1)): 1.4
  - 5. Mapped Spectral Acceleration(Ss Section 1615.1): < 0.75
  - 6. Seismic Design Category (Table 1616.3(1)): D
  - 7. Seismic Importance Factor (IP, Section 1621.1.6): 1.0
  - 8. Component Amplification Factor (aP, Table 1621.3): 1.0
  - 9. Component Response Mod. Factor (Rp, Table 1621.3): 2.5
  - 10. 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.
- B. Forces shall be calculated for the above requirements and Equation 16-67, 68, & 69 in section 1621.1.4, unless exempted by 1621.1.1.

- C. The Contractor shall design the bracing in accordance with TI 809-04. It is recommended that the contractor enlist the services of a qualified seismic bracing vendor/supplier. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. The following companies are listed as resources for the Contractor to consider for obtaining competent assistance regarding the seismic bracing of mechanical piping and equipment. Since seismic constraint is not a common mechanical requirement for projects, and considering that the requirements are specific and include technical expertise, this information may be helpful.

1. Amber Booth
2. Cooper B-Line
3. Mason Industries
4. Tolco (Division of Nibco)

### 1.3 SYSTEM DESCRIPTION

- A. General Requirements: The requirements for seismic protection measures described in this 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. Storage (Buffer) Tanks.
  3. Water Heaters.
  4. Water and Gas Piping.
  5. Expansion and Air Separator Tanks.
  6. Valves and Fittings for Piping.
  7. Heat Exchangers
  8. Fan Coil and Air Handling Units.
  9. Pumps with Motors.
  10. Ductwork.
  11. Unit Heaters.
  12. Supply Fans.
  13. Exhaust and Return Fans.
  14. Evaporative Coolers
- 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 by this section:
1. Install seismic protection of water pipes for fire protection systems in strict accordance with the provision of NFPA 13, Installation of Sprinkler Piping.
  2. Items Requiring No Seismic Restraints: Seismic restraints are not required for the following items:
    - a. Gas piping less than 1 inch inside diameter.
    - b. Piping in boiler and mechanical equipment rooms less than 1-1/4 inches inside diameter.
    - c. All other piping less than 2-1/2 inches inside diameter.
    - d. Rectangular air handling ducts less than 6 square feet in cross sectional area.
    - e. Round air handling ducts less than 28 inches in diameter.
    - f. Piping suspended by individual hangers 12 inches or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.
    - g. Ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.
  3. In exemptions f. and g. 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. 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.
- B. Nonrigid or Flexibly-Mounted Equipment: Nonrigidly 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. The following shall be submitted:
1. Shop Drawings:
    - a. Coupling and Bracing.
    - b. Flexible Couplings or Joints.
    - c. Equipment Requirements.

d. Contractor Designed Bracing.

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

2. Product Data:

- a. Coupling and Bracing
- b. Equipment Requirements
- c. Contractor Designed Bracing

- B. Copies of the design calculations with the drawings. Calculations shall be approved, certified, stamped and signed by a registered Professional Engineer. Calculations shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

## PART 2 - PRODUCTS

### 2.1 SWAY BRACING MATERIALS

- A. Sway bracing materials shall consist of (e.g. rods, plates, rope, angles, etc.) shall conform to the details shown on the Drawings.

### 2.2 MATERIALS AND EQUIPMENT

A. Bolts and Nuts

1. Squarehead bolts and heavy hexagon nuts, ANSI B 18.2.1, Square and Hex Bolts and Screws Inch Series; B18.2.2, Square and Hex Nuts; and ASTM A 307, Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

B. Sway Brace

1. Structure Steel: Conform to ASTM A36, Structural Steel.
2. Steel Pipe: Conform to ASTM A501, Hot Formed Welding and Seamless Carbon Steel Structural Tubing.
3. Steel Bars: Conform to ASTM A576, Steel Bars, Carbon, Hot-Wrought, Special Quality.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Provisions of this Specification apply to all piping within a 5 foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the same intervals as determined by the smallest diameter pipe of the group. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.

### 3.2 BUILDING DRIFT

- A. Joints capable of accommodating seismic displacements shall be provided for vertical piping between floors of the building, where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. Horizontal piping across expansion joints shall accommodate the resultant of the drifts of each building unit in each orthogonal direction. For threaded piping, swing joints made of the same piping material shall be provided. For piping with manufactured ball joints the seismic drift shall be 0.015 feet per foot of height above the base where the seismic separation occurs; this drift value shall be used in place of the expansion given in the manufacturer's selection table.

### 3.3 PIPE SLEEVES

- A. Refer to 15050 for installation requirements.

### 3.4 SPREADERS

- A. Spreaders shall be provided between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart. Spreaders shall be applied at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Spreaders shall be applied to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section.

### 3.5 ANCHOR BOLTS

- A. Cast-In-Place: Floor or pad mounted equipment shall use cast-in-place anchor bolts or Hilti HDA anchors as indicated. One nut shall be provided on each bolt. Anchor bolts shall conform to ASTM F 1554, Grade 36. Anchor bolts shall have an embedded straight length equal to at least 12 times nominal diameter of the

bolt. Anchor bolts that exceed the normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation shall be increased in depth to accommodate bolt lengths.

- B. Expansion or Chemically Bonded Anchors: Expansion or chemically bonded anchors shall not be used unless test data in accordance with ASTM E 488 has been provided to verify the adequacy of the specific anchor and application. Expansion or chemically bonded anchors shall not be used to resist pull-out in overhead and wall installations.

### 3.6 RESILIENT VIBRATION ISOLATION DEVICES

- A. Where the need for these devices is determined, based on the magnitude of the design seismic forces, selection of anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations shall follow the same procedure as in paragraph ANCHOR BOLTS, except that an equipment weight equal to three times the actual equipment weight shall be used.
- B. Multidirectional Seismic Snubbers: Multidirectional seismic snubbers employing elastomeric pads shall be installed on floor- or slab-mounted equipment. These snubbers shall provide 0.25 inches free vertical and horizontal movement from the static deflection point. Snubber medium shall consist of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

### 3.7 SWAY BRACES FOR PIPING

- A. Sway braces shall be provided to prevent movement of the pipes under seismic loading. Braces shall be provided in both the longitudinal and transverse directions, relative to the axis of the pipe. The bracing shall not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications.
- B. Transverse Sway Bracing: Install transverse sway bracing for steel and copper pipe. All runs (length of pipe between end joints) shall have a minimum of two transverse braces.
- C. Longitudinal Sway Bracing: Longitudinal sway bracing shall be provided at 40-foot intervals unless otherwise indicated. All runs (length of pipe between end joints) shall have one longitudinal brace minimum. Branch lines, walls, or floors shall not be used as sway braces.
- D. Vertical Runs: Run is defined as length of pipe between end joints. Vertical runs of piping shall be braced at not more than 10-foot vertical intervals. Braces for

vertical runs shall be above the center of gravity of the segment being braced. Sway braces shall not be connected to branch lines, walls, or floors.

- E. Clamps and Hangers: Clamps or hangers on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps or hangers applied over insulation in accordance with Section 15083.
- F. Anchor Rods, Angles, and Bars: Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in the tabulation below.
- G. Maximum Length for Anchor Braces:

Type	Size (Inches)	Maximum Length* (Feet/Inches)
Angles	1-1/2 x 1-1/2 x 1/4	4-10
	2 x 2 x 1/4	6-6
	2-1/2 x 1-1/2 x 1/4	8-0
	3 x 2-1/2 x 1/4	8-10
	3 x 3 x 1/4	9-10
Rods	3/4	3-1
	7/8	3-8
Flat Bars	1-1/2 x 1/4	1-2
	2 x 1/4	1-2
	2 x 3/8	1-9
Pipes (40S)	1	7-0
	1-1/4	9-0
	1-1/2	10-4
	2	13-1

- i. Bolts: Bolts used for attachment of anchors to pipe and structure shall be not less than 1/2-inch diameter.

### 3.8 SWAY BRACES FOR DUCTS

- A. Braced Ducts: Bracing details and spacing for rectangular and round ducts shall be in accordance with SMACNA Seismic Restraint Manual.
- B. Unbraced Ducts: Hangers for unbraced ducts shall be attached to the duct within 2 inches of the top of the duct with a minimum of two #10 sheet metal screws in accordance with SMACNA Seismic Restraint Manual. Unbraced ducts shall be installed with a 6 inch minimum clearance to vertical ceiling hanger wires.

### 3.9 EQUIPMENT SWAY BRACING

- A. **Suspended Equipment:** Equipment sway bracing shall be provided for items supported from overhead structural systems. Braces shall consist of angles, rods, bars, or pipes and secured at both ends with not less than 1/2-inch bolts. Sufficient braces shall be provided for equipment to resist a horizontal force equal to three times the weight of equipment without exceeding safe working stress of bracing components. Details of equipment bracing shall be submitted for acceptance. In lieu of bracing with vertical supports, these items may be supported and braced with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.
- B. **Floor or Pad Mounted Equipment:**
1. **Shear Resistance:** Floor mounted equipment shall be bolted to the floor. Requirements for the number and installation of bolts to resist shear forces shall be in accordance with paragraph ANCHOR BOLTS.
  2. **Overturning Resistance:** The ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads shall be used to determine if overturning forces need to be considered in the sizing of anchor bolts. Calculations shall be provided to verify the adequacy of the anchor bolts for combined shear and overturning.

END OF SECTION