

**SECTION 210548 VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION  
PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Restraints - rigid type.
5. Restraints - cable type.
6. Restraint accessories.
7. Post-installed concrete anchors.

B. Related Requirements:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
  - a. Seismic-Restraint Selection: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
  - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.

- c. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
  - d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
  - e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" in "Performance Requirements" Article.
  - f. Qualified Professional Engineer: All designated-design submittals for seismic calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic-Restraint Detail Drawing:
- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
  - c. Coordinate seismic restraint details with wind-load restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
3. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
4. All delegated-design submittals for seismic-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
- D. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
- 1.3 INFORMATIONAL SUBMITTALS
- A. Coordination Drawings: Show coordination of seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
  - B. Welding certificates.
  - C. Field quality-control reports.
  - D. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-05, Paragraph 13.2.2, "Special Certification Requirements for

Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active fire-suppression system seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7-05.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic control system.
  1. Seismic Performance: Equipment must be designed and secured to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7-05.
  2. Wind-Load Performance: Equipment must be designed and secured to withstand the effects of high wind events determined in accordance with ASCE/SEI 7-05.
- B. Seismic Design Calculations:
  1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in NFPA 13 and ASCE/SEI 7-05. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the

edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.

- a. Data indicated below to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
  - b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
  - c. Building Risk Category: II.
  - d. Building Site Classification: D.
2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Value is to be calculated by Delegated-Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation.
    - 1)  $SDS$  = Spectral Acceleration: 0.195. Value applies to all components on Project.
    - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
    - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
    - 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from each component submittal.
    - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
    - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated-Design Contractor. For items at or below the base, "z" shall be taken as zero.
    - 7)  $h$  = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.
  - b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
  - c. Seismic Relative Displacement  $D_p$ : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
    - 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated-Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
    - 2)  $I_e$  = Structure Importance Factor: 1. Value applies to all components on Project.
    - 3)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
    - 4)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.

- 5)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
  - 6)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
  - 7)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
  - 8)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
  - 9)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
  - 10)  $h_{sx}$  = Story Height Used in the Definition of the Allowable Drift  $\Delta_a$ : See Drawings Schedules for each component.
- d. Component Fundamental Period  $T_p$ : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
- 1)  $W_p$  = Component Operating Weight: Determined by contractor from Project Drawings and manufacturer's data.
  - 2)  $g$  = Gravitational Acceleration: 32.17 fps<sup>2</sup>.
  - 3)  $K_p$  = Combined Stiffness of Component, Supports, and Attachments: Determined by delegated-design seismic engineer.
3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Calculated by Delegated-Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation.
- 1) SDS = Spectral Acceleration: 0.195. Value applies to all components on Project.
  - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
  - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
  - 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from equipment submittal.
  - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
  - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" shall be taken as zero.
  - 7)  $h$  = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.
- b. Vertical Seismic Design Force: Calculate by Delegated-Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.

- c. Seismic Relative Displacement  $D_p$ : Calculate by Delegated-Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:
- 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated-Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
  - 2)  $I_e$  = Structure Importance Factor: 1. Value applies to all components on Project.
  - 3)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
  - 4)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
  - 5)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
  - 6)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
  - 7)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
  - 8)  $\Delta_aA$  = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
  - 9)  $\Delta_aB$  = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
  - 10)  $h_{sx}$  = Story Height Used in the Definition of the Allowable Drift  $\Delta_a$ : See Drawing Schedule for each component.
4. Calculation Factors, ASCE/SEI 7-05, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Calculated by Delegated-Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation:
- 1)  $SDS$  = Spectral Acceleration: 0.195. Value applies to all components on Project.
  - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
  - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
  - 4)  $W_p$  = Component Operating Weight: Obtain by Delegated-Design Contractor for each component from component submittal.
  - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
  - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determine by Delegated-Design Contractor for each component from Project Drawings. For items at or below the base, "z" shall be taken as zero.

- 7)  $h$  = Average Roof Height of Structure for Base: Determine by Delegated-Design Contractor from Project Drawings.
  - b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
  - c. Seismic Relative Displacement  $D_p$ : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
    - 1)  $\delta_{xA}$  = Deflection at Building Level  $x$  of Structure A: See Drawing Schedule for each component.
    - 2)  $\delta_{yA}$  = Deflection at Building Level  $y$  of Structure A: See Drawing Schedule for each component.
    - 3)  $\delta_{yB}$  = Deflection at Building Level  $y$  of Structure B: See Drawing Schedule for each component.
    - 4)  $h_x$  = Height of Level  $x$  to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
    - 5)  $h_y$  = Height of Level  $y$  to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
    - 6)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
    - 7)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
    - 8)  $h_{sx}$  = Story Height Used in the Definition of the Allowable Drift  $\Delta_a$ : See Drawing Schedule for each component.
- C. Wind-Load Design Calculations:
1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
    - a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
    - b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
  2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
    - a. PART 1: Low-Rise Buildings.
    - b. PART 2: Low-Rise Buildings (Simplified).

- c. PART 3: Buildings with "h" less than 60 feet.
  - d. PART 4: Buildings with "h" greater than 60 feet and less than 160 feet.
  - e. PART 5: Open Buildings.
- D. Consequential Damage: Provide additional seismic and wind-load restraints for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in ASCE/SEI 7-10 so that failure of a non-essential or essential fire-suppression system component will not cause the failure of any other essential architectural, mechanical, or electrical building component.
- E. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- F. Component Supports:
- 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
  - 2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-05 Section 13.6.

## 2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Isolation Technology, Inc.
    - b. Kinetics Noise Control, Inc.
    - c. Korfund.
    - d. Mason Industries, Inc.
    - e. Vibration Eliminator Co., Inc.
    - f. Or approved equal
  - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 3. Size: Factory or field cut to match requirements of supported equipment.
  - 4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
  - 5. Surface Pattern: Smooth, ribbed, or waffle pattern.
  - 6. Infused nonwoven cotton or synthetic fibers.
  - 7. Load-bearing metal plates adhered to pads.
  - 8. Sandwich-Core Material: Resilient and elastomeric.
    - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    - b. Infused nonwoven cotton or synthetic fibers.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

### A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Isolation Technology, Inc.
  - b. Kinetics Noise Control, Inc.
  - c. Korfund.
  - d. Mason Industries, Inc.
  - e. Vibration Eliminator Co., Inc.
  - f. Or approved equal
2. Mounting Plates:
  - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
  - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Kinetics Noise Control, Inc.
  - b. Korfund.
  - c. Mason Industries, Inc.
  - d. nVent (CADDY).
  - e. Vibration Eliminator Co., Inc.
  - f. Or approved equal
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - a. Housing: Cast-ductile iron or welded steel.
  - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.5 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace

member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.6 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton (B-line).
  2. Loos & Co.
  3. nVent (CADDY).
  4. Vibration Mountings & Controls, Inc.
  5. Or approved equal
- B. Seismic-Restraint Cables: ASTM A1023/A12023M galvanized or ASTM A603 galvanized-steel ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.7 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton (B-line).
  2. Hilti, Inc.
  3. Loos & Co.
  4. Mason Industries, Inc.
  5. nVent (CADDY).
  6. Or approved equal
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid restraints and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.8 POST-INSTALLED CONCRETE ANCHORS

### A. Mechanical Anchor Bolts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Atkore International (Unistrut).
  - b. Eaton (B-line).
  - c. Hilti, Inc.
  - d. Mason Industries, Inc.
  - e. Powers Fasteners.
  - f. Or approved equal
- 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

### B. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13.

- 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
- 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

### C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

- 1. Undercut expansion anchors are permitted.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry calculated static and seismic loads within specified loading limits.

3.2 INSTALLATION OF VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Fire-Suppression Vibration Isolation, Seismic, and Wind-Load-Restraint Schedule, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Vibration Isolation, Seismic, and Wind-Load-Restraint Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.
- E. Comply with installation requirements of NFPA 13 for installation of all seismic-restraint devices.
- F. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports and roof penetrations.
- G. Equipment Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- H. Piping Restraints:
  - 1. Comply with all requirements in NFPA 13.
  - 2. Design piping sway bracing in accordance with NFPA 13.
    - a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
    - b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.
- I. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross structural seismic joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for piping flexible connections.

3.4 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. Measure isolator restraint clearance.
  7. Measure isolator deflection.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Units will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 210548