
USACE / NAVFAC / AFCEA / NASA UFGS-13 48 00.00 10 (October 2007)

Preparing Activity: USACE Superseding
UFGS-13 48 00.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2010

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10/07

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SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT 10/07

NOTE: This guide specification covers the requirements for seismic protection of mechanical equipment, building piping, and exterior utilities.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a [Criteria Change Request \(CCR\)](#).

PART 1 GENERAL

NOTE: The intent of this specification is to provide for adequate resistance to lateral forces induced by earthquakes for mechanical equipment and systems described herein. The design seismic lateral forces are in addition to the "normal" gravity forces (weight) acting on the components of a system. This guide specification will be used in conjunction with Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT

Equipment in the following seismic design categories do not require protection from seismic events (refer to UFC 3-310-04 for definition of categories A through F).

- a. Equipment in Seismic Design Categories A and B.
- b. Equipment in Seismic Design Category C when the importance factor is equal to 1.0.

c. Equipment in Seismic Design Categories D, E, and F that are mounted at 1.2 m (4 feet) or less above a floor level and weigh 1780 N (400 lbs) or less and are not critical to the continued operation of the structure.

d. Equipment in Seismic Design Categories C, D, E, and F weighing 95 N (20 lbs) or less or distribution systems weighing 7 N/m (5 lb/ft) or less.

This section can be used for bracing details of medical equipment by editing the specification accordingly.

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325 (2005) Steel Construction Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1650 (2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 2nd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04 (2007; Change 1) Seismic Design for Buildings

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

NOTE: Designer should verify that specified details do not interfere with the performance of the cathodic protection system (when used) or of the vibration isolation systems.

For systems and equipment in buildings that have a performance objective higher than life-safety, the designer should show a "G" classification for the items under SD-02 Shop Drawings in the SUBMITTALS paragraph. The Engineer of Record (EOR) should review the details of these essential systems and assess their impact on the structural supporting system of the essential building.

Apply the requirements for seismic protection measures described in this section to the mechanical equipment and systems listed below. Structural requirements shall be in accordance with Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

1.2.2 Mechanical Equipment

NOTE: The designer must ensure that the list below includes all mechanical items to be braced. Delete the items which are not part of the project and add items which are not included in the list.

For equipment and systems in buildings with a performance objective greater than life-safety, the designer should provide two separate lists of equipment and systems: 1) Items that are essential to the higher level of post-earthquake performance, and 2) Items that are not essential but are necessary to provide a life-safety level of earthquake protection.

Mechanical equipment to be seismically protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

Boilers and furnaces	Storage Tanks for Oil and Water
Water Heaters	Steam, Water, Oil and Gas Piping
Expansion Air Separator Tanks	Valves and Fittings for Piping
Heat Exchangers	Steam-fed Kitchen Appliances
Water Chiller Units	Thermal Storage Units
Cooling Towers	Air and Refrigerant Compressors
Refrigerant Piping	Air Handling Units
Pumps with Motors	Lab Scrubbers
Large Commercial Dryers	Pollution Control Equipment
Gas Dryers	Ducts
Flash Tanks	Unit Heaters
Accumulator Tank	Exhaust and Return Fans

[_____]

Solar Heating Units

1.2.3 Mechanical Systems

NOTE: The designer must ensure that the list below includes all piping and mechanical systems which are to be installed or modified. Delete the items which are not part of the project and add items which are not included in the list.

Install the following mechanical systems as required on the drawings and other sections of these specifications and seismically protect them in accordance with this specification:

- a. All Piping Inside the Building Except as Specifically Stated Below Under "Items Not Covered By This Section".
- b. Chilled Water Distribution Systems Outside of Buildings.
- c. Fuel Piping Outside of Buildings.
- d. All Water Supply Systems.
- e. Storm and Sanitary Sewer Systems.
- f. All Process Piping.
- g. Heat Distribution Systems (Supply, Return, and Condensate Return) Outside of Buildings.
- h. Condenser Water Piping Outside the Building.
- i. Pneumatic Tube Distribution System.
- j. Cold Storage Refrigeration Systems
- k. Fuel Storage Tanks.
- l. Water Storage Tanks.
- m. [_____]

1.2.4 Contractor Designed Bracing

NOTE: Retain this paragraph when the Contractor will design the bracing. The designer will refer and/or modify the listings above or will list below the equipment and systems to receive seismic bracing. Delete this paragraph when all bracing details and locations are indicated on the drawings.

Design the bracing in accordance with **UFC 3-310-04** and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. **UFC 3-310-04** uses parameters for the

building, not for the equipment in the building; therefore, corresponding adjustments to the formulas shall be required. Loadings determined using **UFC 3-310-04** are based on strength design; therefore, **AISC 325** Specifications shall be used for the design. The bracing for the following mechanical equipment and systems shall be developed by the Contractor: [_____].

1.2.5 Items Not Covered By This Section

1.2.5.1 Fire Protection Systems

Seismic protection of piping for fire protection systems shall be installed as specified in Sections **21 30 00** FIRE PUMPS, **21 13 13.00 10** WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION, **21 13 17.00 10** DRY PIPE SPRINKLER SYSTEM, FIRE PROTECTION, **21 13 18.00 10** PREACTION AND DELUGE SPRINKLER SYSTEMS, FIRE PROTECTION, and **21 13 24.00 10** AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM.

1.2.5.2 Items Requiring No Seismic Restraints

NOTE: Retain only those items found in the project for this list of pipes and ducts that do not require seismic restraints. For facilities designated as critical, hazardous, or essential, delete or make exceptions for piping and ducts which will require seismic restraint.

Seismic restraints are not required for the following items:

- a. Gas piping less than **25 mm 1 inch** inside diameter.
- b. Piping in boiler and mechanical equipment rooms less than **32 mm 1-1/4 inches** inside diameter.
- c. All other piping less than **64 mm 2-1/2 inches** inside diameter.
- d. Rectangular air handling ducts less than **0.56 square meters 6 square feet** in cross sectional area.
- e. Round air handling ducts less than **711 mm 28 inches** in diameter.
- f. Piping suspended by individual hangers **300 mm 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 **300 mm 12 inches** or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.

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.

1.3 EQUIPMENT REQUIREMENTS

NOTE: Seismic Control does not guarantee that the equipment itself is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, the manufacturer should be consulted regarding the capabilities of the equipment to withstand seismic loading.

1.3.1 Rigidly Mounted Equipment

NOTE: Rigidly mounted equipment is defined as having a period of vibration of 0.06 seconds or less for the equipment plus its mounting. Equipment with a fundamental period greater than 0.06 seconds should be assumed to be flexibly mounted or nonrigid and designed in accordance with the next paragraph below.

List items that may require additional reinforcements (internally) to prevent permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following a seismic event and to meet the specified requirements (such as boilers, chillers, cooling towers, etc., which consist of a number of individual components built into an assembly by the manufacturers).

The following specific items of equipment: [_____] to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in **UFC 3-310-04**. 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.

Boilers
Chillers
Air-Handling Units
Cooling Towers
Surge Tanks
[_____]

1.3.2 Nonrigid or Flexibly-Mounted Equipment

NOTE: The appropriate lateral force coefficient, based on the guidelines in Section **13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT** for nonrigid or flexibly-mounted equipment, should be calculated and inserted in the second bracketed blank.

The following specific items of equipment to be furnished: [_____] shall be constructed and assembled to resist a horizontal lateral force of [_____] times the operating weight of the equipment at the vertical center of gravity of the equipment.

1.4 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Coupling and Bracing.
Flexible Couplings or Joints.
Equipment Requirements.
Contractor Designed Bracing[; G][; G, [_____]].

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.

SD-03 Product Data

Coupling and Bracing[; G][; G, [____]].
Equipment Requirements[; G][; G, [____]].

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

Contractor Designed Bracing[; G][; G, [____]].

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.

SD-07 Certificates

Flexible Ball Joints.

Flexible ball joints shall be certified to be suitable for the service intended by the manufacturer. Information verifying experience at not less than 3 locations of 2 years' satisfactory operation in a similar application shall be submitted.

PART 2 PRODUCTS

NOTE: Appropriate materials for structural supports must be used in corrosive environments. Dissimilar metals must be isolated.

2.1 FLEXIBLE COUPLINGS

NOTE: Designer should include reference to other specification sections containing provisions for pipe pressure and temperature ratings, if deemed necessary.

Flexible couplings shall have same pressure and temperature ratings as adjoining pipe.

2.2 FLEXIBLE BALL JOINTS

Flexible ball joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation with not less than 15-degree angular movement.

2.3 FLEXIBLE MECHANICAL JOINTS

a. Mechanical couplings for steel or cast iron pipe shall be of the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

b. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets.

2.4 MANUFACTURED BALL JOINTS

Manufactured ball joints shall be as recommended by the manufacturer for the intended use, and shall be approved by the Contracting Officer before installation.

2.5 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

PART 3 EXECUTION

3.1 COUPLING AND BRACING

NOTE: Unless otherwise determined by the Contracting Officer, A-E designs must include complete seismic details showing coupling requirements. Government designer should furnish coupling details for Contractor designed systems if required by the project.

Coupling installation shall conform to the details shown on the drawings. Provisions of this paragraph apply to all piping within a 1.5 m 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 most frequent interval as determined by applying the requirements of this specification to each piping run on the common support. Bracing components shall be sized as required for the total load carried by the common supports. 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

NOTE: Refer to Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT to determine the expected drift of the building. Insert the expected drift ratio (in terms of deflection per unit of height) in the blank space.

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] [_____] meters per meter 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 FLEXIBLE COUPLINGS OR JOINTS

3.3.1 Building Piping

Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers for pipe larger than 90 mm 3-1/2 inches in diameter. Flexible couplings or joints shall be braced laterally without interfering with the action of the flexible coupling or joint. Cast iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to satisfy these requirements.

3.3.2 Underground Piping

NOTE: This paragraph may not be required for some Seismic Design Category structures. The designer will coordinate the requirements for seismic isolation of piping with the structural and civil design drawings to locate flexible connections as required.

The amount of annular space will depend on the stiffness of the foundation assembly and of the surrounding soil, and the distance between the foundation wall and the point outside the building where the pipe is considered to be restrained. The geotechnical engineer will determine the pipe length necessary to provide fixity. As an approximation, a value of 76 mm (3 inches) would be necessary for a pipe penetration in a one-story basement in soft soil.

Underground piping and 100 mm 4 inch or larger conduit, except heat distribution system, shall have flexible couplings installed where the piping enters the building. The couplings shall accommodate [_____] mm inches of relative movement between the pipe and the building in any direction. Additional flexible couplings shall be provided where shown on the drawings.

3.4 PIPE SLEEVES

NOTE: The designer will determine the amount of

differential movement of piping at pipe sleeves passing through non-fire rated walls and partitions and will indicate on the drawings the amount of clearance required between the pipe and the sleeve based on deflection of the pipe between sway braces on either side of the wall.

The designer should avoid pipe penetrations through fire rated assemblies.

Pipe sleeves in interior non-fire rated walls shall be sized as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve. Pipe sleeves in fire rated walls shall conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.5 SPREADERS

NOTE: Refer to UFC 3-310-04 for guidance on separation between pipes and requirements for spreaders.

Spreaders shall be provided between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than [100] [] mm [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 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.6 SWAY BRACES FOR PIPING

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.

3.6.1 Transverse Sway Bracing

NOTE: Piping can be either rigid or flexible. Rigid piping has a period of vibration of 0.06 seconds or less. Piping systems with spacing between braces that exceeds allowable spacing for rigid piping will be deemed flexible and will be designed accordingly.

The designer should provide requirements for bracing PVC pipes.

Transverse sway bracing for steel and copper pipe shall be provided as

specified in Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT. All runs (length of pipe between end joints) shall have a minimum of two transverse braces. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.6.2 Longitudinal Sway Bracing

NOTE: Locate longitudinal sway braces on the drawings for systems subject to thermal expansion because indiscriminate placement of sway braces may interfere with expansion requirements.

Longitudinal sway bracing shall be provided at 12 m 40 foot intervals unless otherwise indicated. All runs (length of pipe between end joints) shall have one longitudinal brace minimum. Sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

3.6.3 Vertical Runs

Run is defined as length of pipe between end joints. Vertical runs of piping shall be braced at not more than 3 m 10 foot vertical intervals. Braces for vertical runs shall be above the center of gravity of the segment being braced. All sway braces shall be constructed in accordance with the drawings. Sway braces shall attach to the structural system and shall not be connected to branch lines, walls, or floors.

3.6.4 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 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.7 SWAY BRACES FOR DUCTS

3.7.1 Braced Ducts

Bracing details and spacing for rectangular and round ducts shall be in accordance with [SMACNA 1650, including Appendix E] [UFC 3-310-04 procedures]. However, the design seismic loadings for these items shall not be less than loadings obtained using the procedures in UFC 3-310-04.

3.7.2 Unbraced Ducts

Hangers for unbraced ducts shall be attached to the duct within 50 mm 2 inches of the top of the duct [with a minimum of two #10 sheet metal screws] [in accordance with SMACNA 1650]. Unbraced ducts shall be installed with a 150 mm 6 inch minimum clearance to vertical ceiling hanger wires.

-- End of Section --