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USACE / NAVFAC / AFCEA / NASA UFGS-13 48 00 (April 2006)  
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Preparing Activity: USACE Replacing without change  
UFGS-13080 (September 2003)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMLR dated 18 July 2006

Latest change indicated by CHG tags

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SECTION 13 48 00

SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT  
04/06

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NOTE: This guide specification covers the requirements for seismic structural elements for protection of mechanical, electrical and miscellaneous equipment. This guide specification will be used in conjunction with Sections 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT and 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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PART 1 GENERAL

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NOTE: The intent of this specification is to provide for adequate resistance to lateral forces induced by earthquakes for listed mechanical, electrical and miscellaneous equipment and systems. The design seismic lateral forces are in addition to the "normal" gravity forces (weight) acting on the components of a system.

Seismic protection will no longer be based on the guidance provided in TM 5-809-10 which includes

seismic zone, importance factors, and building categories. Seismic protection design for anchorage and bracing of all equipment will be based on TI 809-04. The designer will ensure that the A-E and/or Contractor has access to TI 809-04.

The designer has 3 options to provide seismic protection for a project:

1) Hire an A-E who will use this section and will submit calculations and drawings stamped by a registered engineer. The Contracting Officer will "accept" the design but the registered engineer (Engineer of Record) will have final responsibility for the adequacy of the structural members and their connections.

2) Issue a contract requiring the Contractor to hire a registered engineer to submit the stamped calculations and drawings in accordance with this section. The contracting Officer will "accept" the design but the registered engineer (Engineer of Record) will have final responsibility for the adequacy of the structural members and their connections.

3) Perform the design in house, in which case the Government designer will have final responsibility for the adequacy of the structural members and their connections.

Regardless of who performs the design, this section, properly edited, must be included in the construction documents to allow the Contractor to install the seismic protection features.

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

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## 1.1 REFERENCES

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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.

ASME INTERNATIONAL (ASME)

ASME B18.2.1 (1996; R 2005) Square and Hex Bolts and Screws (Inch Series)

ASME B18.2.2 (1987; R 2005) Square and Hex Nuts

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M (2005) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 307 (2004) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

ASTM A 325 (2004b) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 325M (2004b) Structural Bolts, Steel, Heat Treated, 830 Mpa Minimum Tensile Strength (Metric)

ASTM A 36/A 36M (2005) Carbon Structural Steel

ASTM A 500 (2003a) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A 53/A 53M (2004a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 563 (2004a) Carbon and Alloy Steel Nuts

ASTM A 563M (2004) Carbon and Alloy Steel Nuts (Metric)

ASTM A 572/A 572M (2004) High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A 603 (1998; R 2003) Zinc-Coated Steel Structural Wire Rope

ASTM A 653/A 653M (2004a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM E 488 (1996; R 2003) Strength of Anchors in Concrete and Masonry Elements

## 1.2 SYSTEM DESCRIPTION

### 1.2.1 General Requirements

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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. This will allow the Engineer of Record (EOR) to: 1) Do a QC review on the anchorage and bracing details of these essential systems, and 2) Assess the impact of the bracing and anchorage details on the structural supporting system of the essential building.

Design done by the Contractor must be in accordance with TI 809-04. Loadings determined using TI 809-04 are based on strength design; therefore, the AISC 325 specifications should be used to design the steel members in the bracing and anchorage systems.

\*\*\*\*\*

The requirements for seismic protection measures described in this section shall be applied to the mechanical equipment and systems outlined in Section 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT, the electrical equipment and systems outlined in Section 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT, and the miscellaneous equipment and systems listed below. Seismic protection requirements shall be in accordance with TI 809-04 and additional data furnished by the Contracting Officer, and shall be provided in addition to any other requirements called for in other sections of these specifications. The design for seismic protection shall be based on a Seismic Use Group [I] [II] [IIIH] [IIIE] building occupancy and on site response coefficients for  $S_{MS} = [ ]$  and  $S_{M1} = [ ]$ . Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. The basic force formulas, for Ground Motions A and B in Chapter 3 of TI 809-04, use the design spectral response acceleration parameters for the performance objective of the building, not for equipment in the building; therefore, corresponding adjustments to the formulas shall be required.

### 1.2.2 Miscellaneous Equipment and Systems

\*\*\*\*\*

NOTE: The designer must ensure that the list below includes all miscellaneous 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.

\*\*\*\*\*

The bracing for the following miscellaneous equipment and systems shall be developed by the [A-E] [Contractor] in accordance with the requirements of this specification:

Storage cabinets	Ornamentations
Storage Racks	Signs and Billboards
Shelving	Furnishings
Partitions	[_____]

### 1.3 SUBMITTALS

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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.

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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.] The following shall be submitted in accordance with Section

01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bracing[; G][; G, [\_\_\_\_]]  
Resilient Vibration Isolation Devices[; G][; G, [\_\_\_\_]]  
Equipment Requirements[; 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. For equipment and systems in buildings that have a performance objective higher than life-safety, the drawings shall be stamped by the registered engineer who stamps the calculations required above.

SD-03 Product Data

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.

1.4 EQUIPMENT REQUIREMENTS

1.4.1 Rigidly Mounted Equipment

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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. The designer may allow a reduction to the design seismic forces applied to ground-mounted equipment when properly justified in the calculations. 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 an earthquake and to meet the specified requirements. Coordinate with note in paragraph BRACING.

\*\*\*\*\*

The following specific items of equipment: [\_\_\_\_] to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in **TI 809-04**, Chapter 10. For any rigid equipment which is rigidly attached on both sides of a building expansion joint, flexible joints for piping, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions, shall be provided.



#### 1.4.2 Nonrigid or Flexibly-Mounted Equipment

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NOTE: The appropriate lateral force coefficient for nonrigid or flexibly-mounted equipment, should be calculated and inserted in the blank space.  
\*\*\*\*\*

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.

#### PART 2 PRODUCTS

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

##### 2.1 BOLTS AND NUTS

Squarehead and hexhead bolts, and heavy hexagon nuts, ASME B18.2.1, ASME B18.2.2, or [ASTM A 307 for bolts and ASTM A 563M ASTM A 563 for nuts] [ASTM A 325M ASTM A 325 for bolts and nuts]. Bolts and nuts used underground and/or exposed to weather shall be galvanized in accordance with ASTM A 153/A 153M.

##### 2.2 SWAY BRACING

\*\*\*\*\*  
NOTE: Designer should determine an appropriate specification for steel angles used for sway bracing depending on availability of the materials from local suppliers and insert the designation in blank space below.  
\*\*\*\*\*

Material used for members listed [in this section] [and] [on the drawings], shall be structural steel conforming with the following:

- a. Plates, rods, and rolled shapes, [ASTM A 36/A 36M] [ASTM A 572/A 572M, Grade 503]. If the Contractor does the design, both ASTM A 36/A 36M and ASTM A 572/A 572M, grade 503 will be allowed.
- b. Wire rope, ASTM A 603.
- c. Tubes, ASTM A 500, Grade [B] [\_\_\_\_\_] .
- d. Pipes, ASTM A 53/A 53M, Type [E] or [S], Grade B.
- e. Light gauge angles, less than 6 mm 1/4 inch thickness, [ASTM A 653/A 653M] [\_\_\_\_\_] .

## PART 3 EXECUTION

### 3.1 BRACING

\*\*\*\*\*

NOTE: Designs must include complete seismic details showing bracing requirements. The design is for the supports of the equipment, not the equipment itself.

Bracing does not guarantee that the equipment 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.

\*\*\*\*\*

Bracing shall conform to the arrangements shown. Trapeze-type hanger shall be secured with not less than two 13 mm 1/2 inch bolts.

### 3.2 BUILDING DRIFT

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NOTE: The designer will be guided by the results of the seismic analysis to determine the expected drift of the building; this information is needed for the pipe joint designs required in Section 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

\*\*\*\*\*

Sway braces for a piping run shall not be attached to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided.

### 3.3 ANCHOR BOLTS

#### 3.3.1 Cast-In-Place

\*\*\*\*\*

NOTE: The designer will ensure that foundations and anchor bolts for pad-mounted or floor-mounted equipment are detailed and designed in accordance with TI 809-04. When the designer has the necessary size, weight, and other information for a piece of equipment, the anchorage details including sizes, length and number of bolts, thickness and reinforcing of pads and foundations for that piece of equipment will be shown by the designer on the drawings. When this information is not available, it will be the A-E responsibility to design the support and anchorage for the equipment in accordance with the specified requirements.

If the calculated seismic forces would cause the equipment to uplift, the anchor bolts should be designed for combined shear and tension.

\*\*\*\*\*

Floor or pad mounted equipment shall use cast-in-place anchor bolts, except

as specified below. [One nut] [Two nuts] shall be provided on each bolt. Anchor bolts shall conform to **ASTM A 307**. 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.

### 3.3.2 Expansion or Chemically Bonded Anchors

\*\*\*\*\*

**NOTE:** Cast-in-place anchors should be used to anchor equipment for seismic loads since there is considerable experience suggesting that expansion and chemically bonded anchors may come loose during a fire, and do not perform well for vibrating equipment or for other types of cyclic loading, such as earthquakes.

Expansion and chemically bonded anchors should only be allowed when test data show they are applicable for seismic loading. **ASTM E 488** provides a means of testing expansion anchors for seismic loading. In lieu of tests, the designer may specify approval of the expansion anchors by a governmental organization such as the City of Los Angeles or the State of California office of Statewide Health Planning and Development (OSHPD).

The edge distance and spacing between anchor bolts greatly affect the shear and tension capacity of the bolts. The spacing will depend on the type of anchor, the diameter, and the length of embedment. The manufacturer should provide data for the minimum edge distance and bolt spacing needed to achieve the rated values and also ways to reduce the allowables if the edge distance or spacing is less than required.

\*\*\*\*\*

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 if the adhesive is manufactured with temperature sensitive epoxies and the location is accessible to a building fire. Expansion and chemically bonded anchors shall be installed in accordance with the manufacturer's recommendations. The allowable forces shall be adjusted for the spacing between anchor bolts and the distance between the anchor bolt and the nearest edge, as specified by the manufacturer.

#### 3.3.2.1 General Testing

\*\*\*\*\*

**NOTE:** Expansion and chemically bonded anchors should be tested after installation. Testing every expansion anchor is not necessary or practical; therefore a reasonable rate of testing should be developed depending on the importance of the job. There are two methods of testing: Torque wrench and

pullout testing. The torque test is easier and cheaper and usually gives a good indication of installation quality; the pullout test gives a better indication of the strength of both expansion and chemically bonded anchors. The torque test does not apply to expansion bolts which are anchored by hammering the sleeve over a cone such as self drilling anchors.

\*\*\*\*\*

Expansion and chemically bonded anchors shall be tested in place after installation. The tests shall occur not more than [24] [\_\_\_\_\_] hours after installation of the anchor and shall be conducted by an independent testing agency; testing shall be performed on random anchor bolts as described below.

#### 3.3.2.2 Torque Wrench Testing

\*\*\*\*\*

NOTE: Delete this paragraph for expansion anchors which are not anchored by an applied torque, such as self drilling anchors.

Torque wrench testing verifies that a torqued expansion anchor has seated properly. If it has not seated, the applied torque on the nut will cause the bolt to twist in the hole. Torque wrench testing does not load the bolt up to allowable load and therefore does not verify the capacity of the installed bolt.

\*\*\*\*\*

Torque wrench testing shall be done on not less than [50] [\_\_\_\_\_] percent of the total installed expansion anchors and at least [one anchor] [[\_\_\_\_\_] anchors] for every piece of equipment containing more than [two] [\_\_\_\_\_] anchors. The test torque shall equal the minimum required installation torque as required by the bolt manufacturer. Torque wrenches shall be calibrated at the beginning of each day the torque tests are performed. Torque wrenches shall be recalibrated for each bolt diameter whenever tests are run on bolts of various diameters. The applied torque shall be between 20 and 100 percent of wrench capacity. The test torque shall be reached within one half turn of the nut, except for 9 mm 3/8 inch sleeve anchors which shall reach their torque by one quarter turn of the nut. If any anchor fails the test, similar anchors not previously tested shall be tested until [20] [\_\_\_\_\_] consecutive anchors pass. Failed anchors shall be retightened and retested to the specified torque; if the anchor still fails the test it shall be replaced.

#### 3.3.2.3 Pullout Testing

\*\*\*\*\*

NOTE: Pullout testing is expensive and labor intensive because of the apparatus needed to pull on the anchor bolt. Pullout testing determines the tension capacity of the anchor bolt. The amount of load to be applied can vary between 0.5 to 2 times the calculated load, depending on the importance of the bolt. There is not a significant cost difference between testing to 0.5 or 2 times the

calculated load; since most anchor bolts have a factor of safety of 4, testing to twice the specified load should not cause any distress. The typical tension failure causes a shear cone to be pulled out of the concrete, the slope of the cone is about a 45 degree angle so there should be nothing on the concrete surface in the vicinity of the bolt to prevent the cone from pulling out. Shear testing is usually not needed unless the bolt is heavily loaded in shear and close to an edge.

\*\*\*\*\*

Expansion and chemically bonded anchors shall be tested by applying a pullout load using a hydraulic ram attached to the anchor bolt. At least [5] [\_\_\_\_\_] percent of the anchors, but not less than [3] [\_\_\_\_\_] per day shall be tested. The load shall be applied to the anchor without removing the nut; when that is not possible, the nut shall be removed and a threaded coupler shall be installed of the same tightness as the original nut. The test setup shall be checked to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures.

The support for the testing apparatus shall be at least 1.5 times the embedment length away from the bolt being tested. Each tested anchor shall be loaded to [1] [\_\_\_\_\_] times the design tension value for the anchor. The anchor shall have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested shall be tested until [20] [\_\_\_\_\_] consecutive anchors pass. Failed anchors shall be retightened and retested to the specified load; if the anchor still fails the test it shall be replaced.

### 3.4 RESILIENT VIBRATION ISOLATION DEVICES

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 [five] [\_\_\_\_\_] times the actual equipment weight shall be used.

#### 3.4.1 Resilient and Spring-Type Vibration Devices

\*\*\*\*\*

**NOTE:** Retain either this paragraph or the one below, as required by the project. Remove the paragraph not needed.

\*\*\*\*\*

Vibration isolation devices shall be selected so that the maximum movement of equipment from the static deflection point shall be 13 mm 0.5 inches.

#### 3.4.2 Multidirectional Seismic Snubbers

\*\*\*\*\*

**NOTE:** Details of multidirectional seismic snubbers will be shown in drawings if paragraph is retained.

\*\*\*\*\*

Multidirectional seismic snubbers employing elastomeric pads shall be installed on floor- or slab-mounted equipment. These snubbers shall provide 6 mm 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.

### 3.5 SWAY BRACES FOR PIPING

\*\*\*\*\*  
The bracing requirements shown below are based on flexible piping. Supports for flexible piping must consider an additional amplification of the piping being in resonance with the building.  
\*\*\*\*\*

Transverse sway bracing for steel and copper pipe shall be provided at intervals not to exceed those shown on the drawings. 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. Bracing shall consist of at least one vertical angle 50 x 50 mm x 16 gauge 2 x 2 inches x 16 gauge and one diagonal angle of the same size.

#### 3.5.1 Longitudinal Sway Bracing

Longitudinal sway bracing shall be provided in accordance with Section 13 48 00.00 10 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT.

#### 3.5.2 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.

#### 3.5.3 Maximum Length for Anchor Braces

Type	Size (millimeters)	Maximum Length* (meters)
Angles	38 x 38 x 6	1.5
	50 x 50 x 6	2.0
	64 x 38 x 6	2.5
	75 x 64 x 6	2.5
	75 x 75 x 6	3.0
Rods	91	1.0
	22	1.0
Flat Bars	38 x 6	0.4
	50 x 6	0.4
	50 x 10	0.5
Pipes (40s)	25	2.0
	32	2.8
	40	3.2
	50	4.0

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

#### 3.5.4 Bolts

Bolts used for attachment of anchors to pipe and structure shall be not less than 13 mm 1/2 inch diameter.

### 3.6 EQUIPMENT SWAY BRACING

#### 3.6.1 Suspended Equipment and Light Fixtures

\*\*\*\*\*

NOTE: Equipment weighing more than one-fifth of the dead load of slabs above grade at the equipment level or equipment weighing more than one-tenth of the building weight must be checked by structural analysis to conform with building seismic provisions. Such equipment has a pronounced effect on the response of the building. The following items shall be checked structurally and specific seismic requirements incorporated on appropriate drawings and in the relevant specifications.

Pole or frame supported equipment.

Storage tanks for water and oil.

Storage racks with upper storage level more than 2.4 m (8 feet) in height.

Smoke stacks taller than 15 m (50 feet) in height.

See Chapter 10 of TI 809-04 to compute the force needed to fill in the bracketed blank.

\*\*\*\*\*

Equipment sway bracing shall be provided for items supported from overhead floor or roof structural systems, including light fixtures. Braces shall

consist of angles, rods, wire rope, bars, or pipes arranged as shown and secured at both ends with not less than 13 mm 1/2 inch bolts. Sufficient braces shall be provided for equipment to resist a horizontal force as specified in Chapter 10 of TI 809-04 without exceeding safe working stress of bracing components. The Contractor shall provide, for approval, specific force calculations in accordance with Chapter 10 of TI 809-04 for the equipment in the project. Details of equipment bracing shall be submitted for acceptance. In lieu of bracing with vertical supports, these items may be supported 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.

### 3.6.2 Floor or Pad Mounted Equipment

#### 3.6.2.1 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.

#### 3.6.2.2 Overturning Resistance

\*\*\*\*\*  
NOTE: See Chapter 10 of TI 809-04 for guidance on  
design of anchor bolts.  
\*\*\*\*\*

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.

### 3.7 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

\*\*\*\*\*  
NOTE: Include this paragraph only when special  
inspection and testing for seismic-resisting systems  
is required by paragraph 3.2 of FEMA 302, NEHRP  
RECOMMENDED PROVISIONS FOR SEISMIC REGULATIONS FOR  
NEW BUILDINGS AND OTHER STRUCTURES.

This paragraph will be applicable to both new  
buildings designed according to TI 809-04, SEISMIC  
DESIGN FOR BUILDINGS, and to existing building  
seismic rehabilitation designs done according to TI  
809-05, SEISMIC EVALUATION AND REHABILITATION FOR  
BUILDINGS.

The designer must indicate on the drawings all  
locations and all features for which special  
inspection and testing is required in accordance  
with Chapter 3 of FEMA 302. This includes  
indicating the locations of all structural  
components and connections requiring inspection.



Add any additional requirements as necessary.

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Special inspections and testing for seismic-resisting systems and components shall be done in accordance with Section 01 45 35 SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS.

-- End of Section --