Chapter 6

ARCHITECTURAL, MECHANICAL, AND ELECTRICAL COMPONENTS DESIGN REQUIREMENTS

6.1 GENERAL: This chapter establishes minimum design criteria for architectural, mechanical, electrical, and nonstructural systems, *components*, and elements permanently attached to *structures*, including supporting *structures* and attachments (hereinafter referred to as "*components*"). The design criteria establish minimum equivalent static force levels and relative displacement demands for the design of *components* and their attachments to the *structure*, recognizing ground motion and structural amplification, *component* toughness and weight, and performance expectations.

This chapter also establishes minimum seismic design force requirements for *nonbuilding structures* that are supported by other *structures*. Seismic design requirements for *nonbuilding structures* that are supported at grade are prescribed in Chapter 14. However, the minimum seismic design forces for *nonbuilding structures* that are supported by another *structure* shall be determined in accordance with the requirements of Sec. 6.1.3 with R_p equal to the value of R specified in Chapter 14 and $a_p = 2.5$ for *nonbuilding structures* with flexible dynamic characteristics and $a_p = 1.0$ for *nonbuilding structures* with rigid dynamic characteristics. The distribution of lateral forces for the supported *nonbuilding structure* and all nonforce requirements specified in Chapter 14 shall apply to supported *nonbuilding structures*.

> **Exception:** For *structures* in *Seismic Design Categories* D, E and F if the combined weight of the supported *components* and *nonbuilding structures* with flexible dynamic characteristics exceeds 25 percent of the weight of the *structure*, the *structure* shall be designed considering interaction effects between the *structure* and the supported items.

Seismic Design Categories for *structures* are defined in Sec. 4.2. For the purposes of this chapter, *components* shall be considered to have the same *Seismic Design Category* as that of the *structure* that they occupy or to which they are attached unless otherwise noted.

In addition, all *components* are assigned a *component* importance factor (I_p) in this chapter. The default value for I_p is 1.00 for typical *components* in normal service. Higher values for I_p are assigned for *components* that contain hazardous substances, must have a higher level of assurance of function, or otherwise require additional attention because of their life-safety characteristics. *Component* importance factors are prescribed in Sec. 6.1.5.

All architectural, mechanical, electrical, and other nonstructural *components* in *structures* shall be designed and constructed to resist the equivalent static forces and displacements determined in accordance with this chapter. The design and evaluation of support *structures* and architectural *components* and equipment shall consider their flexibility as well as their strength.

> **Exception:** The following *components* are exempt from the requirements of this chapter:

1. All *components* in *Seismic Design Category* A,
2. Architectural *components* in *Seismic Design Category* B other than parapets supported by bearing walls or shear walls when the importance factor (I_p) is equal to 1.00,
3. Mechanical and electrical *components* in *Seismic Design Category* B,
4. Mechanical and electrical *components* in *Seismic Design Category* C when the importance factor (I_p) is equal to 1.00,
5. Mechanical and electrical *components* in *Seismic Design Categories* D, E, and F where I_p= 1.0 and flexible connections between the *components* and associated ductwork, piping, and conduit are provided or that are mounted at 4 ft (1.22 m) or less above a floor level and weigh 400 lb (1780 N) or less, or
6. Mechanical and electrical *components* in *Seismic Design Categories* C, D, E, and F where I_p= 1.0 and flexible connections between the *components* and associated ductwork, piping, and conduit are provided that weigh 20 lb (95 N) or less or, for distribution systems, weight 5 lb/ft (7 N/m) or less.

The functional and physical interrelationship of *components* and their effect on each other shall be considered so that the failure of an essential or nonessential architectural, mechanical, or electrical *component* shall not cause the failure of an essential architectural, mechanical, or electrical *component*.

6.1.1 References and Standards:

6.1.1.1 Consensus Standards: The following references are consensus standards and are to be considered part of these provisions to the extent referred to in this chapter:

ASME A17.1	American Society of Mechanical Engineers (ASME), ASME A17.1, *Safety Code For Elevators And Escalators*, 1996.
ASTM C635	American Society For Testing And Materials (ASTM), ASTM C635, *Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings*, 1997.
ASME/BPV	American Society of Mechanical Engineers (ASME/BPV), *Boiler and Pressure Vessel Code*, including addendums through 2000.
ASTM C636	American Society for Testing and Materials (ASTM), ASTM C636, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels*, 1996.

ANSI/ASME B31.1	American National Standards Institute/American Society of Mechanical Engineers, ANSI/ASME B31.1-98, *Power Piping*
ANSI/ASME B31.3	American National Standards Institute/American Society of Mechanical Engineers, ANSI/ASME B31.3-96, *Process Piping*
ANSI/ASME B31.4	American National Standards Institute/American Society of Mechanical Engineers, ANSI/ASME B31.4-92, *Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols*
ANSI/ASME B31.5	American National Standards Institute/American Society of Mechanical Engineers, ANSI/ASME B31.5-92, *Refrigeration Piping*
ANSI/ASME B31.8	American National Standards Institute/American Society of Mechanical Engineers, ANSI/ASME B31.8-95, *Gas Transmission and Distribution Piping Systems*
ANSI/ASME B31.9	American National Standards Institute/American Society of Mechanical Engineers, ANSI/ASME B31.9-96, *Building Services Piping*
ANSI/ASME B.31.11	American National Standards Institute/American Society of Mechanical Engineers, ANSI/ASME B31.11-89 (Reaffirmed, 1998), *Slurry Transportation Piping Systems*
NFPA-13	National Fire Protection Association (NFPA), NFPA-13, *Standard for the Installation of Sprinkler Systems*, 1999.
IEEE- 344	Institute of Electrical and Electronic Engineers (IEEE). Standard 344, *Recommended Practice for Seismic Qualification of Class I E Equipment for Nuclear Power Generating Stations*, 1987.

6.1.1.2 Accepted Standards: The following references are standards developed within the industry and represent acceptable procedures for design and construction:

ASHRAE SRD	American Society of Heating, Ventilating, and Air Conditioning (ASHRAE), *Handbook*, “Seismic Restraint Design,”1999.
CISCA Recs./Zones 0-2	Ceilings and Interior Systems Construction Association (CISCA), *Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings, Seismic Zones 0-2*, 1991.
CISCA Recs/ Zones 3-4	Ceilings and Interior Systems Construction Association (CISCA), *Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings*, *Seismic Zones 3-4*, 1991.
SMACNA HVAC	Sheet Metal and Air Conditioning Contractors National Association (SMACNA), *HVAC Duct Construction Standards, Metal and Flexible,* 1995.

SMACNA Rectangular	Sheet Metal and Air Conditioning Contractors National Association (SMACNA), *Rectangular Industrial Duct Construction Standards*, 1980.
SMACNA Restraint	Sheet Metal and Air Conditioning Contractors National Association (SMACNA), *Seismic Restraint Manual Guidelines for Mechanical Systems*, 1991, including Appendix B, 1998.
AAMA 501.4	American Architectural Manufacturers Association (AAMA), *Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts*. Publication No. AAMA 501.4-2000.

6.1.2 Component Force Transfer: *Components* shall be attached such that the *component* forces are transferred to the *structure*. *Component* seismic *attachments* shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity. A continuous load path of sufficient strength and stiffness between the *component* and the supporting *structure* shall be verified. Local elements of the supporting structure shall be verified for the *component* forces where they control the design of the elements or their connections. The *component* forces shall be those determined in Section 6.1.3, except that modifications to F_p and R_p due to anchorage conditions need not be considered. The design documents shall include sufficient information relating to the *attachments* to verify compliance with the requirements of these provisions.

6.1.3 Seismic Forces: Seismic forces (F_p) shall be determined in accordance with Eq. 6.1.3-1:

$$F_p = \frac{0.4 a_p S_{DS} W_p}{\frac{R_p}{I_p}} \left(1 + 2\frac{z}{h} \right) \tag{6.1.3-1}$$

$$F_p = 1.6 S_{DS} I_p W_p \tag{6.1.3-2}$$

F_p is not required to be taken as greater than:

and F_p shall not be taken as less than:

$$F_p = 0.3 S_{DS} I_p W_p \tag{6.1.3-3}$$

where:

F_p = Seismic design force centered at the *component*'s center of gravity and distributed relative to *component*'s mass distribution.

S_{DS} = Spectral acceleration, short period, as determined from Sec. 4.1.2.5.

a_p = *Component* amplification factor that varies from 1.00 to 2.50 (select appropriate value from Table 6.2.2 or Table 6.3.2).

I_p = *Component* importance factor that is either 1.00 or 1.50 (see Sec.).

W_p = *Component* operating weight.

R_p = *Component* response modification factor that varies from 1.0 to 5.0 (select appropriate value from Table 6.2.2 or Table 6.3.2).

z = Height in *structure* of point of attachment of *component*. For items at or below the base, z shall be taken as 0. The value of z/h need not exceed 1.0.

h = Average roof height of *structure* relative to grade elevation.

The force, F_p, shall be applied independently longitudinally and laterally in combination with service loads associated with the *component*. Combine horizontal and vertical load effects as indicated in Sec. 5.2.7 substituting F_p for the term Q_E. The reliability/redundancy factor, ρ, is permitted to be taken equal to 1.

When positive and negative wind loads exceed F_p for nonstructural exterior walls, these wind loads shall govern the design. Similarly, when the building code horizontal loads exceed F_p for interior partitions, these building code loads shall govern the design.

In lieu of the forces determined in accordance with Eq. 6.1.3-1, accelerations at any level may be determined by the modal analysis procedures of Sec. 5.5 with R = 1.0. Seismic forces shall be in accordance with Eq. 6.1.3-4:

$$F_p = \frac{a_i a_p W_p}{R_p / I_p} A_x \qquad (6.1.3\text{-}4)$$

Where a_i is the acceleration at level *I* obtained from the modal analysis.

The upper and lower limits of F_p determined by Eq. 6.1.3-2 and 3 apply.

6.1.4 Seismic Relative Displacements: Seismic relative displacements (D_p) shall be determined in accordance with the following equations:

$$D_p = \delta_{xA} - \delta_{yA} \qquad (6.1.4\text{-}1)$$

D_p is not required to be taken as greater than:

$$D_p = (X - Y)\frac{\Delta_{aA}}{h_{sx}} \qquad (6.1.4\text{-}2)$$

For two connection points on separate *Structures* A and B or separate structural systems, one at level x and the other at level y, D_p shall be determined as:

$$D_p = \left|\delta_{xA}\right| + \left|\delta_{yB}\right| \qquad (6.1.4\text{-}3)$$

D_p is not required to be taken as greater than:

$$D_p = \frac{X\Delta_{aA}}{h_{sx}} + \frac{Y\Delta_{aB}}{h_{sx}} \qquad (6.1.4\text{-}4)$$

where:

D_p = Relative seismic displacement to the *component* must be designed to accommodate.

δ_{xA} = Deflection at building level x of *Structure* A, determined by an elastic analysis as defined in Sec. 5.2.8 and multiplied by the C_d factor.

δ_{yA} = Deflection at building level y of *Structure* A, determined by an elastic analysis as defined in Sec. 52.8 and multiplied by the C_d factor.

δ_{yB} = Deflection at building level y of *Structure* B, determined by an elastic analysis as defined in Sec. 5.2.8 and multiplied by the C_d factor.

X = Height of upper support attachment at level x as measured from the base.

Y = Height of lower support attachment at level y as measured from the base.

Δ_{aA} = Allowable story drift for *Structure* A as defined in Table 5.2.8.

Δ_{aB} = Allowable story drift for *Structure* B as defined in Table 5.2.8.

h_{sx} = Story height used in the definition of the allowable drift, Δ_a, in Table 5.2.8. Note that Δ_a/h_{sx} = the allowable drift index.

The effects of seismic relative displacements shall be considered in combination with displacement caused by other loads as appropriate.

6.1.5 Component Importance Factor: The *component* importance factor, I_p, shall be selected as follows:

$I_p = 1.5$ Life safety *component* is required to function after an earthquake.

I_p = 1.5 *Component* contains *hazardous contents*.

I_p = 1.5 Storage racks in occupancies open to the general public (e.g., warehouse retails stores).

I_p = 1.0 All other *components*.

In addition, for *structures* in *Seismic Use Group* III:

I_p = 1.5 All *components* needed for continued operation of the facility or whose failure could impair the continued operation of the facility.

6.1.6 Component Anchorage: *Components* shall be anchored in accordance with the following provisions.

6.1.6.1: The force in the connected part shall be determined based on the prescribed forces for the *component* specified in Sec. 6.1.3. Where *component* anchorage is provided by shallow expansion anchors, shallow chemical anchors or shallow (low deformability) cast-in-place anchors, a value of R_p = 1.5 shall be used in Sec. 6.1.3 to determine the forces in the connected part.

6.1.6.2: Anchors embedded in concrete or masonry shall be proportioned to carry the least of the following:

a. The design strength of the connected part,

b. 1.3 times the force in the connected part due to the prescribed forces, and

c. The maximum force that can be transferred to the connected part by the *component* structural system.

6.1.6.3: Determination of forces in anchors shall take into account the expected conditions of installation including eccentricities and prying effects.

6.1.6.4: Determination of force distribution of multiple anchors at one location shall take into account the stiffness of the connected system and its ability to redistribute loads to other anchors in the group beyond yield.

6.1.6.5: Power driven fasteners shall not be used for tension load applications in *Seismic Design Categories* D, E, and F unless approved for such loading.

6.1.6.6: The design strength of the anchors shall be determined in accordance with the provisions in Chapter 9.

6.1.6.7: For additional requirements for anchors to steel, see Chapter 10.

6.1.6.8: For additional requirements for anchors in masonry, see Chapter 11.

6.1.6.9: For additional requirements for anchors in wood, see Chapter 12.

6.1.7 Construction Documents: Construction documents shall be prepared by a registered design professional in a manner consistent with the requirements of the *Provisions*, as indicated in Table 6.1.7, in sufficient detail for use by the *owner*, building officials, contractors, and inspectors.

TABLE 6.1.7 Construction Documents

Component Description	Provisions Reference		Required Seismic Design Categories
	Quality Assurance	Design	
Exterior nonstructural wall elements, including anchorage	3.2.8 No. 1	6.2.4	D, E, F
Suspended ceiling system, including anchorage	3.2.8 No. 3	6.2.6	D, E, F
Access Floors, including anchorage	3.8 No. 2	6.2.7	D, E, F
Steel storage racks, including anchorage	3.2.8 No. 2	6.2.9	D, E, F
Glass in *glazed curtain walls, glazed storefronts* and interior glazed *partitions*, including anchorage.	3.3.9 No. 3	6.2.10	D, E, F
HVAC ductwork containing hazardous materials, including anchorage.	3.2.9 No. 4	6.3.10	C, D, E, F
Piping systems and mechanical units containing flammable, combustible, or highly toxic materials.	3.2.9 No. 3	6.3.11 6.3.12 6.3.13	C, D, E, F
Anchorage of electrical equipment for emergency standby power systems	3.2.9 No. 1	6.3.14	C, D, E, F
Anchorage for all other electrical equipment	3.2.9 No. 2	6.3.14	E, F
Project-specific requirements for mechanical and electrical *components* and their anchorage	3.3.5	6.30	C, D, E, F

6.2 ARCHITECTURAL COMPONENT DESIGN:

6.2.1 General: Architectural systems, *components*, or elements (hereinafter referred to as "*components*") listed in Table 6.2.2 and their attachments shall meet the requirements of Sec. 6.2.2 through Sec. 6.2.9.

6.2.2 Architectural Component Forces and Displacements: Architectural *components* shall meet the force requirements of Sec. 6.1.3 and 6.4 and Table 6.2.2.

Exception: *Components* supported by chains or otherwise suspended from the structural system above are not required to meet the lateral seismic force requirements and seismic relative *displacement* requirements of this section provided that they cannot be damaged or cannot damage any other *component* when subject to seismic motion and they have ductile or articulating connections to the *structure* at the point of attachment. The gravity design load for these items shall be three times their operating load.

TABLE 6.2.2 Architectural Components Coefficients

Architectural Component or Element	**a_p[a]**	**R_p[b]**
Interior Nonstructural Walls and Partitions (See also Sec. 6.8)		
Plain (unreinforced) masonry walls	1.0	1.5
All other walls and partitions	1.0	2.5
Cantilever Elements (Unbraced or braced to structural frame below its center of mass)		
Parapets and cantilever interior nonstructural walls	2.5	2.5
Chimneys and stacks where laterally supported by *structures*.	2.5	2.5
Cantilever elements (Braced to structural fame above its center of mass)		
Parapets	1.0	2.5
Chimneys and Stacks	1.0	2.5
Exterior Nonstructural Walls	1.0[b]	2.5
Exterior Nonstructural Wall Elements and Connections (see also Sec. 6.2.4)		
Wall Element	1.0	2.5
Body of wall panel connections	1.0	2.5
Fasteners of the connecting system	1.25	1
Veneer		
High deformabiliy elements and attachments	1.0	2.5
Low deformability and attachments	1.0	1.5
Penthouses (except when framed by an extension of the building frame)	2.5	3.5
Ceilings (see also Sec. 6.2.6)		
All	1.0	2.5
Cabinets		
Storage cabinets and laboratory equipment	1.0	2.5
Access floors (see also Sec. 6.2.7)		
Special access floors (designed in accordance with Sec. 6.2.7.2)	1	2.5
All other	1	1.5

Appendages and Ornamentations	2.5	2.5
Signs and Billboards	2.5	2.5
Other Rigid *Components*		
High deformability elements and attachments	1.0	3.5
Limited deformability elements and attachments	1.0	2.5
Low deformability elements and attachments	1.0	1.5
Other flexible *components*		
High deformability elements and attachments	2.5	3.5
Limited deformability elements and attachments	2.5	2.5
Low deformability elements and attachments	2.5	1.5

[a] A lower value for a_p may be justified by detailed dynamic analysis. The value for a_p shall not be less than 1.00. The value of a_p = 1 is for equipment generally regarded as rigid and rigidly attached. The value of a_p = 2.5 is for flexible *components* or flexibility attached *components*. See Chapter 2 for definitions of rigid flexible *components* including attachments.

[b] Where flexible diaphragms provide lateral support for walls and partitions, the design forces for anchorage to the diaphragm shall be specified in Sec. 5.2.5.

6.2.3 Architectural Component: Architectural *components* that could pose a life-safety hazard shall be designed for the seismic relative displacement requirements of Sec. 6.1.4. Architectural *components* shall be designed for vertical deflection due to joint rotation of cantilever structural members.

6.2.4 Exterior Nonstructural Wall Elements and Connections:

6.2.4.1 General: Exterior nonstructural wall panels or elements that are attached to or enclose the *structure* shall be designed to resist the forces in accordance with Eq. 6.1.3-1 or 6.1.3-2 and shall accommodate movements of the *structure* resulting from response to the design basis ground motion, D_p, or temperature changes. Such elements shall be supported by means of positive and direct structural supports or by mechanical connections and fasteners in accordance with the following requirements:

a. Connections and panel joints shall allow for a relative movement between stories for not less than the calculated story drift D_p or ½ in. (13 mm), whichever is greater..

b. Connections to permit movement in the plane of the panel for story drift shall be sliding connections using slotted or oversize holes, connections that permit movements by bending of steel, or other connections that provide equivalent sliding or ductile capacity.

c. Bodies of connectors shall have sufficient deformability and rotation capacity to preclude fracture of the concrete of low deformation failures at or near welds.

d. All fasteners in the connecting system such as bolts, inserts, welds, and dowels and the body of the connectors shall be designed for the force, F_p, determined in by Eq. 6.1.3-2 with vallues of R_p and a_p taken from Table 6.2.2 applied at the center of mass of the panel.

e. Anchorage using flat straps embedded in concrete or masonry shall be attached to or hooked around reinforcing steel or otherwise terminated so as to effectively transfer forces to the reinforcing steel.

6.2.4.2 Glass: Glass is a *glazed curtain walls and storefronts* shall be designed and installed in accordance with sec. 6.2.10.

6.2.5 Out-of-Plane-Bending: Transverse or out-of-plane bending or deformation of a *component* or system that is subjected to forces as determined in Sec. 6.1.3 shall not exceed the deflection capacity of the *component* or system.

6.2.6 Suspended Ceilings: Suspended ceilings shall be designed to meet the seismic force requirements of Sec. 6.2.6.1. In addition, suspended ceilings shall meet the requirements of either Industry Standard Construction as modified in Sec. 6.2.6.2 or integral construction as specified in Sec. 6.2.6.3.

6.2.6.1 Seismic Forces: Suspended ceilings shall be designed to meet the force requirements of Sec. 6.1.3.

The weight of the ceiling, W_p, shall include the ceiling grid and panels; light fixtures if attached to, clipped to, or laterally supported by the ceiling grid; and other *components* that are laterally supported by the ceiling. W_p shall be taken as not less than 4 psf (19 N/m^2).

The seismic force, F_p, shall be transmitted through the ceiling attachments to the building structural elements or the ceiling-*structure* boundary.

Design of anchorage and connections shall be in accordance with these provisions.

6.2.6.2 Industry Standard Construction: Unless designed in accordance with Sec. 6.2.6.3, suspended ceilings shall be designed and constructed in accordance with this section.

6.2.6.2.1 Seismic Design Category C: Suspended ceilings in Seismic Design Category C shall be designed and installed in accordance with CISCA Rec for Zones 0-2, except that seismic forces shall be determined in accordance with Sec. 6.1.3 and 6.2.6.1.

Sprinkler heads and other penetrations in Seismic Design Category C shall have a minimum of 1/4 inch (6 mm) clearance on all sides.

6.2.6.2.2 Seismic Design Categories D, E, and F: Suspended ceilings in *Seismic Design Categories* D, E, and F be designed and installed in accordance with CISCA Rec for Zones 3-4 and the additional requirements listed in this subsection.

a. A heavy duty T-bar grid system shall be used.

b. The width of the perimeter supporting closure angle shall be not less than 2 in. (50 mm). In each orthogonal horizontal direction, one end of the ceiling grid shall be attached to the closure angle. The other end in each horizontal direction shall have a 3/4 in. (19 mm) clearance from the wall and shall rest upon and be free to slide on a closure angle.

c. For ceiling areas exceeding 1000 ft^2 (92.9 m^2), horizontal restraint of the ceiling to the structural system shall be provided. The tributary areas of the horizontal restraints shall be approximately equal.

> **Exception:** Rigid braces are permitted to be used instead of diagonal splay wires. Braces the attachments to the structural system above shall be adequate to limit relative lateral deflections at point of attachment of ceiling grid to less than 1/4 in. (6 mm) for the loads prescribed in Sec. 6.1.3.

d. For ceiling areas exceeding 2500 ft^2 (232 m^2), a seismic separation joint or full height partition that breaks the ceiling up into areas not exceeding 2500 ft^2 shall be provided unless structural analyses are performed of the ceiling bracing system for the prescribed seismic forces which demonstrate ceiling system penetrations and closure angles provide sufficient clearance to accommodate the additional movement. Each areas shall be provided with closure angles in accordance with Item b and horizontal restraints or bracing in accordance with Item c.

e. Except where rigid braces are used to limit lateral deflections, sprinkler heads and other penetrations shall have a 2 in. (50 mm) oversize ring, sleeve, or adapter through the ceiling tile to allow for free movement of at least 1 in. (25 mm) in all horizontal directions. Alternatively, a swing joint can accommodate 1 in. (25 mm) of ceiling movements in all horizontal directions are permitted to be provided at the top of the sprinkler head extension.

f. Changes in ceiling plan elevation shall be provided with positive bracing.

g. Cable trays and electrical conduits shall be supported independently of the ceiling.

h. Suspended ceilings shall be subject to the special inspection requirements of Sec. 3.3.9 of the *Provisions*.

6.2.6.3 Integral Ceiling/Sprinkler Construction: As a alternative to providing large clearances around sprinkler system penetrations through ceiling systems, the sprinkler system and ceiling grid are permitted to be designed and tied together as an integral unit. Such a design shall consider the mass and flexibility of all elements involved, including: ceiling system, sprinkler system, light fixtures, and mechanical (HVAC) appurtenances. The design shall be performed by a *registered design professional*.

6.2.7 Access Floors:

6.2.7.1 General: Access floors shall be designed to meet the force provisions of Sec. 6.1.3 and the additional provisions of this section. The weight of the access floor, W_p, shall include the weight of the floor system, 100 percent of the weight of all equipment fastened to the floor, and 25 percent of the weight of all equipment supported by but not fastened to the floor. The seismic force, F_p, shall be transmitted from the top surface of the access floor to the supporting *structure*.

Overturning effects of equipment fastened to the access floor panels also shall be considered. The ability of "slip on" heads for pedestals shall be evaluated for suitability to transfer overturning effects of equipment.

When checking individual pedestals for overturning effects, the maximum concurrent axial load shall not exceed the portion of W_p assigned to the pedestal under construction.

6.2.7.2 Special Access Floors: Access floors shall be considered to be "special access floors" if they are designed to comply with the following considerations:

1. Connections transmitting seismic loads consist of mechanical fasteners, concrete anchors, welding, or bearing. Design load capacities comply with recognized design codes and/or certified test results.
2. Seismic loads are not transmitted by friction produced solely by the effects of gravity, powder-actuated fasteners (shot pins), or adhesives.
3. The bracing system shall be designed considering the destabilizing effects of individual members buckling in compression.
4. Bracing and pedestals are of structural or mechanical shape produced to ASTM specifications that specify minimum mechanical properties. Electrical tubing shall be used.
5. Floor stingers that are designed to carry axial seismic loads that are mechanically fastened to the supporting pedestals are used.

6.2.8 Partitions:

6.2.8.1 General: *Partitions* that are tied to the ceiling and all partitions greater than 6 ft (1.8 m) in height shall be laterally braced to the building *structure*. Such bracing shall be independent o f any ceiling splay bracing. Bracing shall be spaced to limit horizontal deflection at the partition head to comparable with ceiling deflection requirements as determined in Sec. 6.2.6 for suspended ceilings and Sec. 6.2.2 for other systems.

6.2.8.2 Glass: Glass in glazed *partitions* shall be designed and installed in accordance with Sec. 6.2.10.

6.2.9 Steel Storage Racks: Steel storage racks shall be designed to meet the force requirements of Chapter 14.

6.2.10 Glass in Glazed Curtain Walls, Glazed Storefronts, and Glazed Partitions:

6.2.10.1 General: Glass in *glazed curtain walls, glazed storefronts* and glazed partitions shall meet the relative displacement requirement of Eq. 6.2.10.1-1:

$$\Delta_{fallout} \geq 1.25 I D_p \qquad (6.2.10.1\text{-}1)$$

or 0.5 inch (13 mm), whichever is greater, where:

$\Delta_{fallout}$ = the relative seismic displacement (drift) causing glass fallout from the curtain wall, storefront wall or partition (Section 6.2.10.2).

D_p = the relative seismic displacement that the *component* must be designed to accommodate (Eq. 6.1.4-1). D_p shall be determined over the height of the glass *component* under consideration.

I = the occupancy importance factor (Table 1.4).

Exceptions:

1. Glass with sufficient clearances from its frame such that physical contact between the glass and frame will not occur at the design drift, as demonstrated by Eq. 6.2.10.1-2, shall be exempt from the provisions of Eq. 6.2.10.1-1:

$$D_{clear} \geq 1.25 D_p \qquad (6.2.10.1\text{-}2)$$

or 0.5 inch (13 mm); whichever is greater, where:

$$D_{clear} = 2c_1\left(1 + \frac{h_p c_2}{b_p c_1}\right)$$

h_p = the height of the rectangular glass,

b_p = the width of the rectangular glass,

c_1 = the clearance (gap) between the vertical glass edges and the frame, and

c_2 = the clearance (gap) between the horizontal glass edges and the frame.

2. Fully tempered monolithic glass in *Seismic Use Groups I* and *II* located no more than 10 ft (3 m) above a walking surface shall be exempt from the provisions of Eq. 6.2.10.1-1.

3. Annealed or heat-strengthened laminated glass in single thickness with interlayer no less than 0.030 in. (0.76 mm) that is captured mechanically in a wall system glazing pocket, and whose perimeter is secured to the frame by a wet glazed gunable curing elastomeric sealant perimeter bead of ½ in. (13 mm) minimum glass contact width, or other approved anchorage system, shall be exempt from the provisions of Eq. 6.2.10.1-1.

6.2.10.2 Seismic Drift Limits for Glass Components: $\Delta_{fallout}$, the drift causing glass fallout from the curtain wall, storefront or partition, shall be determined in accordance with SMACNA Restraint, or by engineering analysis.

6.3 MECHANICAL AND ELECTRICAL COMPONENT DESIGN:

6.3.1 General: Attachments and equipment supports for the mechanical and electrical systems, *components*, or elements (hereinafter referred to as "*components*") shall meet the requirements of Sec. 6.3.2 through Sec. 6.3.16.

6.3.2 Mechanical and Electrical Component Forces and Displacements: Mechanical and electrical *components* shall meet the force and seismic relative displacement requirements of Sec. 6.1.3, Sec. 6.1.4, and Table 6.3.2.

Some complex equipment such as valve operators, turbines and generators, and pumps and motors are permitted to be functionally connected by mechanical links not capable of transferring the seismic loads or accommodating seismic relative displacements and may require special design considerations such as a common rigid support or skid.

> **Exception:** *Components* supported by chains or similarly suspended from the *structure* above or not required to meet the lateral seismic force requirements and seismic relative displacement requirements of this section provided that they cannot be damaged or cannot damage any other *component* when subject to seismic motion and they have high deformation or articulating connections to the building at the point of attachment. The gravity design load for these items shall be three times their operating load.

TABLE 6.3.2 Mechanical and Electrical Components Coefficients

Mechanical and Electrical Component or Element[b]	a_p[a]	R_p
General Mechanical		
Boilers and Furnaces	1.0	2.5
Pressure vessels on skirts and free-standing	2.5	2.5
Stacks	2.5	2.5
Cantilevered chimneys	2.5	2.5
Other	1.0	2.5
Manufacturing and Process Machinery		
General	1.0	2.5
Conveyors (nonpersonnel)	2.5	2.5
Piping Systems		
High deformability elements and attachments	1.0	3.5
Limited deformability elements and attachments	1.0	2.5
Low deformability elements and attachments	1.0	1.5

Mechanical and Electrical Component or Element[b]	a_p[a]	R_p
HVAC System Equipment		
Vibration isolated	2.5	2.5
Non-vibration isolated	1.0	2.5
Mounted in-line with ductwork	1.0	2.5
Other	1.0	2.5
Elevator *Components*	1.0	2.5
Escalator *Components*	1.0	2.5
Trussed Towers (free-standing or guyed)	2.5	2.5
General Electrical		
Distributed systems (bus ducts, conduit, cable tray)	2.5	5
Equipment	1.0	2.5
Lighting Fixtures	1.0	1.5

[a] A lower value for a_p is permitted provided a detailed dynamic analysis is performed which justifies a lower limit. The value for a_p shall not be less than 1.00. The value of $a_p = 1$ is for equipment generally regarded as rigid or rigidly attached. The value of $a_p = 2.5$ is for flexible *components* or flexibly attached *components*. See Chapter 2 for definitions of rigid and flexible *components* including attachments.

[b] *Components* mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$ if the maximum clearance (air gap) between the equipment support frame and restraint is greater than 1/4 inch. If the maximum clearance is specified on the *construction documents* to be not greater than 1/4 inch, the design force may be taken as F_p.

6.3.3 Mechanical and Electrical Component Period: The fundamental period of the mechanical and electrical *component* (and its attachment to the building), T_p, may be determined by the following equation provided that the *component* and attachment can be reasonably represented analytically by a simple spring and mass single-degree-of-freedom system:

$$T_p = 2\pi\sqrt{\frac{W_p}{K_p g}} \qquad (6.3.3)$$

where:

T_p = *Component* fundamental period,

W_p = *Component* operating weight,

g = Gravitational acceleration, and

K_p = Stiffness of resilient support system of the *component* and attachment, determined in terms of load per unit deflection at the center of gravity of the *component*.

Note that consistent units must be used.

Alternatively, determine the fundamental period of the *component* in seconds, T_p, from experimental test data or by a properly substantiated analysis.

6.3.4 Mechanical and Electrical Component Attachments: The stiffness of mechanical and electrical *component* attachments shall be designed such that the load path for the *component* performs its intended function.

6.3.5 Component Supports: Mechanical and electrical *component* supports and the means by which they are attached to the *component* shall be designed for the forces determined in Sec. 6.1.3 and in conformance with Chapters 5 though 9, as appropriate, for the materials comprising the means of attachment. Such supports include structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, ans tethers. *Component* supports may be forged or cast as a part of the mechanical or electrical *component*. If standard or proprietary supports are used, they shall be designed by either load rating (i.e., testing) or for the calculated seismic forces. In addition, the stiffness of the support, when appropriate, shall be designed such that the seismic load path for the *component* performs its intended function.

Component supports shall be designed to accommodate the seismic relative displacements between points of support determined in accordance with Sec. 6.1.4.

In addition, the means by which supports are attached to the *component*, except when integral (i.e., cast or forged), shall be designed to accommodate both the forces and displacements determined in accordance with Sec. 6.1.3 and 6.1.4. If the value of I_p = 1.5 for the *component*, the local region of the support attachment point to the *component* shall be evaluated for the effect of the load transfer on the *component* wall.

6.3.6 Component Certification: The manufacturer's certificate of compliance with the force requirements of the *Provisions* shall be submitted to the regulatory agency when required by the contract documents or when required by the regulatory agency.

6.3.7 Utility and Service Lines at Structure Interfaces: At the interface of adjacent *structures* or portions of the same *structure* that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the *structure*. Differential displacement calculations shall be determined in accordance with Sec. 6.1.4.

6.3.8 Site-Specific Considerations: The possible interruption of utility service shall be considered in relation to designated seismic systems in *Seismic Use Group III* as defined in Sec. 1.3.1. Specific attention shall be given to the vulnerability of underground utilities and utility interfaces between the *structure* and the ground in all situations where *Site Class* E and F soil is present and where the seismic coefficient C_a is equal to or greater than 0.15.

6.3.9 Storage Tanks:

6.3.9.1 Above-Grade Storage Tanks: For storage tanks mounted above grade in *structures*, attachments, supports, and the tank shall be designed to meet the force requirements of Chapter 14.

6.3.10 HVAC Ductwork: Attachments and supports for HVAC ductwork systems shall be designed to meet the force and displacement requirements of Sec. 6.1.3 and 6.1.4 and the additional requirements of this section. In addition to their attachments and supports, ductwork systems designated as having I_p greater than 1.0 shall be designed to meet the force and displacement requirements of Sec. 6.1.3 and 6.1.4 and the additional requirements of this section. Where HVAC ductwork runs between *structures* that could displace relative to one another and for isolated *structures* where the HVAC ductwork crosses the isolation interface, the HVAC ductwork shall be designed to accommodate the seismic relative displacements specified in Sec. 6.1.4.

Seismic restraints are not required for HVAC ducts with I_p = 1.0 if either of the following conditions are met for the full length of each duct run:

a. HVAC ducts are suspended from hangers, and all hangers are 12 in. (305 mm) or less in length from the top of the duct to the supporting *structure* and the hangers are detailed to avoid significant bending of the hangers and their attachments.

or

b. HVAC ducts have a cross-sectional area of less than 6 ft^2 (0.557 m^2).

HVAC duct systems fabricated and installed in accordance with the SMACNA HVAC, SMACNA Rectangular, and SMACNA Restraint shall be deemed to meet the lateral bracing requirements of this section.

Equipment items installed in-line with the duct system (e.g., fans, heat exchangers, and humidifiers) with an operating weight greater than 75 lb (334 N) shall be supported and laterally braced independently of the duct system and shall meet the force requirements of Sec. 6.1.3. Appurtenances such as dampers, louvers, and diffusers shall be positively attached with mechanical fasteners. Unbraced piping attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.

6.3.11 Piping Systems: Attachments and supports for piping systems shall be designed to meet the force and displacement requirements of Sec. 6.1.3 and 6.1.4 and the additional requirements of this section. In addition to their attachments and supports, piping systems designated as having I_p greater than 1.0 shall be designed to meet the force and displacement provisions of Sec. 6.1.3 and 6.1.4 and the additional requirements of this section. When piping systems are attached to *structures* that could displace relative to one another and for isolated *structures*, including foundations, where the piping system crosses the isolation interface, the piping system shall be designed to accommodate the seismic relative displacements specified in Sec. 6.1.4.

Seismic effects that shall be considered in the design of a piping system include the dynamic effects of the piping system, its contents, and, when appropriate, its supports. The interaction between the piping system and the supporting *structures*, including other mechanical and electrical equipment, also shall be considered.

See Sec. 6.3.16 for elevator system piping requirements.

6.3.11.1 Fire Protection Sprinkler Systems: Fire protection sprinkler systems designed and constructed in accordance with NFPA 13 shall be deemed to meet the force, displacement, and other requirements of this section provided that the seismic design force and displacement calculated in accordance with NFPA 13, multiplied by a factor of 1.4, is not less than that determined using the *Provisions*.

6.3.11.2 Other Piping Systems. The following documents have been adopted as national standards by the American National Standards Institute (ANSI) and are appropriate for use in the seismic design of piping systems provided that the seismic design forces and displacements used are comparable to those determined using the *Provisions*: ANSI/ASME B31.1, ANSI/ASME B31.3, ANSI/ASME B31.4, ANSI/ASME B31.5, ANSI/ASME B31.9, ANSI/ASME B31.11, and ANSI/ASME 31.8.

> **Exception:** Piping systems designated as having an I_p greater than 1.0 shall not be designed using the simplified analysis procedures of ANSI/ASME B31.9, Sec. 919.4.1 (a).

The following requirements shall also be met for piping systems designated as having an I_p greater than 1.0.

a. Under design loads and displacements, piping shall not be permitted to impact other *components*.

b. Piping shall accommodate the effects of relative displacements that may occur between piping support points on the *structure* on the ground, other mechanical and/or electrical equipment, and other piping

6.3.11.2.1 Supports and Attachments for Other Piping: In addition to meeting the force, displacement, and other requirements of this section, attachments and supports for piping shall be subject to the following other requirements and limitations.

a. Attachments shall be designed in accordance with Sec. 6.1.6.

b. Seismic supports are not required for:

    1. Piping supported by rod hangers provided that all hangers in the pipe run are 12 in. (305 mm) or less in length from the top of the pipe to the supporting *structure* and the pipe can accommodate the expected deflections. Rod hangers shall not be constructed in a manner that would subject the rod to bending moments.

    2. High deformability piping in *Seismic Design Categories* D, E, and F designated as having I_p greater than 1.0 and a nominal pipe size of 1 in. (25 mm) or less when

provisions are made to protect the piping from impact or to avoid the impact of larger piping or other mechanical equipment.

3. High deformability piping in *Seismic Design Category* C designated as having an I_p greater than 1.0 and a nominal pipe size of 2 in. (51 mm) or less when provisions are made to protect the piping from impact or to avoid the impact of larger piping or other mechanical equipment.

4. High deformability piping in *Seismic Design Categories* D, E, and F designated as having an I_p equal to 1.0 and a nominal pipe size of 3 in. (76 mm) or less.

c. Seismic supports shall be constructed so that support engagement is maintained.

6.3.12 Boilers and Pressure Vessels: Attachments and supports for boilers and pressure vessels shall be designed to meet the force and displacement provisions of Sec. 6.1.3 and 6.1.4 and the additional provisions of this section. In addition to their attachments and supports, boilers and pressure vessels designated as having an I_p = 1.5 themselves shall be designed to meet the force and displacement provisions of Sec. 6.1.3 and 6.1.4.

Seismic effects that shall be considered in the design of a boiler or pressure vessel include the dynamic effects of the boiler or pressure vessel and it supports, sloshing of liquid contents, loads from attached *components* such as piping, and the interaction between the boiler or pressure vessel and its support.

6.3.12.1 ASME Boilers and Pressure Vessels: Boilers or pressure vessels designed in accordance with ANSI/ASME B31.9 shall be deemed to meet the force, displacement, and other requirements of this section. In lieu of the specific force and displacement provisions provided in the ASME code, the force and displacement provisions of Sec. 6.1.3 and 6.1.4 shall be used.

6.3.12.2 Other Boilers and Pressure Vessels: Boilers and pressure vessels designated as having an I_p = 1.5 but not constructed in accordance with the provisions of ANSI/ASME B31.9 shall meet the following provisions:

a. The design strength for seismic loads of combination with other service loads and appropriate environmental effects shall not exceed the following:

(1) For boilers and pressure vessels constructed with ductile materials (e.g., steel aluminum or copper), 90 percent of the material minimum specified yield strength .

(2) For threaded connections in boilers or pressure vessels or their supports constructed with ductile materials, 70 percent of the material minimum specified yield strength.

(3) For boilers and pressure vessels constructed with nonductile materials (e.g., plastic, cast iron, or ceramics), 25 percent of the material minimum specified tensile strength.

(4) For threaded connections in boilers or pressures vessels or their supports constructed with nonductile materials, 20 percent of the material minimum specified tensile strength.

b. Provisions shall be made to mitigate seismic impact for boiler and pressure vessel *components* constructed of nonductile materials or in cases where material ductility is reduced (e.g., low temperature applications).

c. Boilers and pressure vessels shall be investigated to ensure that the interaction effects between them and other constructions are acceptable.

6.3.12.3 Supports and Attachments for Boilers and Pressure Vessels: Attachments and supports for boilers and pressure vessels shall meet the following provisions:

a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with nationally recognized structural code such as, when constructed of steel, AISC LRFD and AISC ASD (see Chapter 8 for full references).

b. Attachments embedded in concrete shall be suitable for cyclic loads.

c. Seismic supports shall be constructed so that support engagement is maintained.

6.3.13 Mechanical Equipment Attachments and Supports: Attachments and supports for mechanical equipment not covered in Sec. 6.3.8 through 6.3.12 or 6.3.16 shall be designed to meet the force and displacement requirements of Sec. 6.1.3 and 6.1.4 and the additional requirements of this section. In addition, mechanical equipment designated as having an I_p greater than 1.0 shall be designed to meet the force and displacement requirements of Sec. 6.1.3 and 6.1.4 and the additional requirements of this section.

When required, seismic effects that shall be considered in the design of mechanical equipment, attachments and their supports include dynamic effects of the equipment, its contents, and when appropriate its supports. The interaction between the equipment and the supporting *structures*, including other mechanical and electrical equipment, also shall be considered.

6.3.13.1 Mechanical Equipment: Mechanical equipment having an I_p greater than 1.0 shall meet the following requirements:

a. Provisions shall be made to eliminate seismic impact for equipment *components* vulnerable to impact, equipment *components* constructed of nonductile materials, and in cases where material ductility is reduced (e.g., low temperature applications).

b. The possibility for loadings imposed on the equipment by attached utility or service lines due to differential motions of points of support from separate *structures* shall be evaluated.

In addition, *components* of mechanical equipment designated as having an I_p greater than 1.0 and containing sufficient material that would be hazardous if released shall be designed for seismic loads. The design strength for seismic loads in combination with other service loads and appropriate environmental effects such as corrosion shall be based on the following:

a. For mechanical equipment constructed with ductile materials (e.g., steel, aluminum, or copper), 90 percent of the equipment material minimum specified yield strength.

b. For threaded connections in equipment constructed with ductile materials, 70 percent of the material minimum specified yield strength.

c. For mechanical equipment constructed with nonductile materials (e.g., plastic, cast iron, or ceramics), 25 percent of the equipment material minimum tensile strength.

d. For threaded connections in equipment constructed with nonductile, 20 percent of the material minimum specified yield strength.

6.3.13.2 Attachments and Supports for Mechanical Equipment: Attachments and supports for mechanical equipment shall meet the following requirements:

a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designated and constructed in accordance with a nationally recognized standard specification such as, when constructed of steel, AISC LRFD and AISC ASD.

b. Friction clips shall not be used for anchorage attachment.

c. Expansion anchors shall not be used for non-vibration isolated mechanical equipment rated over 10 hp (7.45 kW).

> **Exception:** Undercut expansion anchors are permitted.

d. Supports shall be specifically evaluated if weak-axis bending of cold-formed support steel is relied on for the seismic load path.

e. *Components* mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction, and vertical restraints shall be provided where required to resist overturning. Isolator housings and restraints shall be constructed of ductile materials. (See additional design force requirements in Table 6.3.2.) A viscoelastic pad or similar material of appropriate thickness shall be used between the bumper and equipment item to limit the impact load.

f. Seismic supports shall be constructed so that support engagement is maintained.

6.3.14 Electrical Equipment Attachments and Supports: Attachments and supports for electrical equipment shall be designed to meet the force and displacement requirements of Sec. 6.1.3 and 6.1.4 and the additional requirements of this section. In addition, electrical equipment designated as having I_P greater than 1.0 shall be designed to meet the force displacement requirements of Sec. 6.1.3 and 6.1.4 and the additional requirements of this section.

Seismic effects that shall be considered in the design of other electrical equipment include the dynamic effects of the equipment, its contents, and, when appropriate, its supports. The interaction between the equipment and the supporting *structures*, including other mechanical and electrical equipment, also shall be considered. When conduit, cable trays, or similar electrical distribution *components* are attached to *structures* that could displace relative to one another and for isolated *structures* where the conduit or cable trays cross the isolation interface, the conduit or cable trays shall be designed to accommodate the seismic relative displacements specified in Sec. 6.1.4.

6.3.14.1 Electrical Equipment: Electrical equipment designed as having an I_p greater than 1.0 shall meet the following requirements:

a. Provisions shall be made to eliminate seismic impact between the equipment and other *components*.

b. The loading on the equipment imposed by attached utility or service lines that also are attached to separate *structures* shall be evaluated.

c. Batteries on racks shall have wrap-around restraints to ensure that the batteries will not fall off the rack. Spacers shall be used between restraints and cells to prevent damage to cases. Racks shall be evaluated for sufficient lateral load capacity.

d. Internal coils of dry type transformers shall be positively attached to their supporting substructure within the transformer enclosure

e. Slide out *components* in electrical control panels, computer equipment, etc., shall have a latching mechanism to hold contents in place.

f. Electrical cabinet design shall conform to the applicable National Electrical Manufacturers Association (NEMA) standards. Cut-outs in the lower shear panel that do not appear to have been made by the manufacturer and are judged to significantly reduce the strength of the cabinet shall be specifically evaluated.

g. The attachment of additional external items weighing more than 100 pounds (445 N) shall be specifically evaluated if not provided by the manufacturer.

6.3.14.2 Attachments and Supports for Electrical Equipment: Attachments and supports for electrical equipment shall meet the following requirements:

a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural standard specification such as, when constructed of steel, AISC LRFD and AISC and ASD.

b. Friction clips shall not be used for anchorage attachment.

c. Oversized plate washers extending to the equipment wall shall be used at bolted connections through the base sheet metal if the base is not reinforced with stiffeners or not judged capable of transferring the required loads.

d. Supports shall be specifically evaluated if weak-axis bending of light gage support steel is relied on for the seismic load path.

e. The supports for linear electrical equipment such as cable trays, conduit, and bus ducts shall be designed to meet the force and displacement requirements of Sec. 6.1.3 and 6.1.4 if any of the following situations apply:

(1) Supports are cantilevered up from the floor;

(2) Supports include bracing to limit deflection;

(3) Supports are constructed as rigid welded frames;

(4) Attachments into concrete utilize non-expanding insets, shot pins, or cast iron embedments;

(5) Attachments utilize spot welds, plug welds, or minimum size welds as defined by AISC.

f. *Components* mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction, and vertical restraints shall be provided where required to resist overturning. Isolator housings and restraints shall not be constructed of cast iron or other materials with limited ductility. (See additional design force requirements in Table 6.3.2.) A viscoelastic pad or similar material or appropriate thickness shall be used between the bumper and equipment item to limit the impact load.

6.3.15 Alternate Seismic Qualification Methods: As an alternative to the analysis methods implicit in the design methodology described above, equipment testing is an acceptable method to determine seismic capacity. Thus, adaptation of a nationally recognized standard, such as CISCA Recs for Zones 3-4, is acceptable so long as the equipment seismic capacity equals or exceeds the demand expressed in Sec. 6.1.3 and 6.1.4.

6.3.16 Elevator Design Requirements: Elevators shall meet the force and displacement provisions of Sec. 6.3.2 unless exempted by either Sec. 1.2 or Sec. 6.1. Elevators designed in accordance with the seismic provisions of ASME A17.1 shall be deemed to meet the seismic force requirements of this section, except they also shall meet the additional requirements provided in Sec. 6.3.16.1 through 6.3.16.4.

6.3.16.1 Elevators and Hoistway Structural System: Elevators and hoistway structural systems shall be designed to meet the force and displacement provisions of Sec. 6.3.2.

6.3.16.2 Elevator Machinery and Controller Supports and Attachments: Elevator machinery and controller supports and attachments shall be designed to meet the force and displacement provisions of Sec. 6.3.2.

6.3.16.3 Seismic Controls: Seismic switches shall be provided for all elevators addressed by Sec. 6.3.16.1, including those meeting the requirements of ASME A17.1, provided they operate with a speed of 150 ft/min (46 m/min) or greater. Seismic switched shall provide an electrical signal indicating that structural motions are of such a magnitude that the operation of elevators may be impaired. Upon activism of the seismic switch, elevator operations shall conform the provisions of ASME A17.1 except as noted below. The seismic switch shall be located at or above the highest floor serviced by the elevator. The seismic switch shall have two horizontal perpendicular axes of sensitivity. Its trigger level shall be set to 30 percent of the acceleration of gravity in facilities where the loss of the use of an elevator is a life-safety issue, the elevator may be used after the seismic switch has triggered provided that:

1. The elevator shall operate no faster than the service speed,
2. The elevator shall be operated remotely from top to bottom and back to top to verify that it is operable, and
3. The individual putting the elevator back in service should ride the elevator from top to bottom and back to top to verify acceptable performance.

6.3.16.4 Retainer Plates: Retainer plates are required at the top and bottom of the car and counterweight.